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Shell Beds on the Skagerack.

By

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Introduction.

The large and abundant deposits of shells of marine molluscs and cirripeds on the Skagerack long since attracted the attention of LINNAEUS and LYELL. Beds of Arctic animals began accumulating as the submerged land was released from the last ice sheet, and deposits of successively different faunas have been forming ever since. The net result of the changes of level being emergence, the majority of the beds are raised above the sea — the oldest, as a rule, being raised the most.

The shell beds shed light chiefly on three vital problems of the Quaternary geology, viz. immigration and evolution of the fauna, temperature, and changes of level, as well as on associations, zoögeography, etc. Their study necessitated surveys of the regional and bathymetrical distribution of the animals and of the mode of formation of shell beds. Much work is still needed on these problems.

The field work was carried out in 1915, 1917, and 1919. It covered the greater part of the coastal belt between Göteborg and Oslo. The study of the mode of formation of shell beds was partly made at Kristineberg Zoölogical Station, Fiskebäckskil. The field studies in 1917 and 1919 were supported by grants from the Liljewalch Fund of the University of Stockholm. The material of five beds in northern Bohuslän was collected by Baron GERARD DE GEER.

The analyzing of the shell gravel was done in 1917 to 1919, the material being at the University of Stockholm.

The writing of the text was largely done at the American Museum of Natural History in New York and was facilitated by the excellent library of the museum.

The writer is indebted for advice, assistance, and courtesy to Baron GERARD DE GEER, Dr. HJALMAR ÖSTERGREN of Kristineberg Zoölogical Station, Ph. Cand. FOLKE FOLKESON of Stockholm and to Dr. CHESTER A. REEDS, Miss IDA R. HOOD, and the assistant librarians of the American Museum of Natural History.

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I. Regional Division of the European Seas and Classification of the Molluscs.

To make it possible conveniently to express the climatological significance of a fauna in a shell bed in Scandinavia a classification of the animals found in them with regard to their modern range in north and south has been made.

The classification is based on the old zoögeographical division of the European seas into arctic, boreal, and lusitanian,[1] provinces. As upon the release from the ice the fauna was arctic, and as the majority of the molluscs are now distributed far south of the Scandinavian waters, the most important thing is to determine the southern limit of distribution of a few high-arctic species and the northern limit of the bulk of the molluscs. These points have therefore been stressed. Only the distribution in European, mainly north European, seas has been considered. Only the regions and subregions that are necessary for our purpose have been distinguished. A division of the extra-European seas has for that matter recently been made by Hägg (1924, p. 481).

For the division all available literature has been used. This is given in the bibliography. The work was largely done in 1919 and partly carried out by my good friend Ph. Cand. Folke Folkeson of Stockholm.

In the arctic region (a) are included the seas down to North Cape and Iceland. The mean surface temperature of the ocean at the southern limit is between 4° and 5° C. (Mohn, 1887, p. 16; Pettersson, 1908, p. 29; Schott, 1926, Pl. 10; Thompson, 1916, Fig. 4), and the bottom temperature on the continental shelf is about 3° C. (Petersen, 1915). The annual mean temperature of the air within this region ranges from below — 10° to + 1.8° C. (Hägg, 1924, p. 481). The faunistic boundary is not very marked, but a number of distinctly arctic species occur down to Lofoten especially in the cold waters of the skerry guard and the fjords, and various boreal forms are met with east and north of North Cape, in regions where the Gulf Stream makes itself particularly felt (Sars, 1878, p. 2; 1879).

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[1] Pertaining to ancient Lusitania, corresponding in part to modern Portugal.

The arctic region has been divided into a high-arctic and a low-arctic subregion.

The high-arctic subregion (a^h) is identical with APPELLÖF's (1912, p. 457) arctic region. In it are counted the seas of Franz Josef Land, Spitsbergen, Novaya Zemlya, northern USSR westward to the White Sea, the seas of Jan Mayen and Greenland down to the Denmark Strait, and also the deep central basin of the Norwegian Sea. Temperature and salinity are rather uniform. »The temperature is usually below 0° C., though in summer the actual surface may show higher temperatures under the influence of the sun. But the sun's heat does not penetrate so deeply as in the boreal region. The salinity varies greatly at the surface, but at the depth of a few meters it is rarely less than 30 per thousand.» (APPELLÖF.)

The low-arctic subregion (a^l) is almost identical with APPELLÖF's boreo-arctic region and HÄGG's (1924, p. 482) low-arctic region. It includes the White Sea, the Barents Sea of the Kola Peninsula and Östfinnmark, the waters of the northern and eastern shores of Iceland, etc. It comprises primarily those parts of the Arctic Ocean that are reached by the warm waters of the Gulf Stream. The annual mean temperature of the surface water ranges from about 1° to some 4° or 5° C. In summer time the water is heated considerably above these figures, and the mean temperature for August at the southern limit is between 8° and 10° C. The annual mean air temperature of this subregion ranges between — 1.9° and + 1.8° C. (HÄGG, 1924, p. 482).

The boreal region (b) is, in accordance with APPELLÖF, considered as including the seas along the European continent from North Cape to the eastern part of the English Channel, i. e. the eastern part of the Norwegian Sea, the North Sea with the Skagerack and the Kattegatt and the waters of the Faeroe Islands and of the southern and western coasts of Iceland. It includes, in other words, those parts of the seas mentioned that consist of Gulf Stream water or coastal water. The annual mean temperature of the surface water ranges from 4° or 5° to 11° C. The boreal region has been divided into a high-boreal, a mid-boreal, and a low-boreal subregion.

The high-boreal subregion (b^h) is considered as extending from North Cape to north of Lofoten. A boundary has been drawn between Vesterålen and Lofoten because about 30 of our species reach their northern limit at Lofoten and a number of distinctly arctic species are common and of normal size down to that point.

The water temperature in the area has an insignificant range. The mean surface temperature for the year is 4° to 5° or slightly above, and that for the month of August ranges from about 9° to 11° C. The bottom temperature is 3° and above, probably 3° to 4° C.

The mid-boreal subregion (b^m) is considered as extending from north of Lofoten to south of the Trondhjemsfjorden. The mean surface temperature of the ocean ranges for the year from about 5° to 7° C. and for the month of August from 11° to 13° C. The mean annual range of the temperature is 8° to 9° C. (THOMPSON, 1916, Fig. 2.) The bottom temperature is about 4° C. The annual mean air temperature at the southern boundary is about 6° C.

The low-boreal subregion (b^l) is considered to extend from south of the Trondhjemsfjorden to the eastern part of the English Channel. It includes all of the North Sea and the waters of the Faeroes. The mean surface temperature for the year ranges from 7° to 11°, that for August from 13° to 17°, and that for February from 2° to 6° C. (Deutsche Seewarte, 1902, 1927; THOMPSON, 1916; SCHOTT, 1926, Pl. 9). The mean annual range increases from 4° at the Faeroes to 14° C. in the eastern Skagerack. The temperature at the bottom is from 4° to 7° or 8° C.

The lusitanian region (l) comprises the shallow seas south of and west of the Scotland-Faeroe Ridge and the eastern part of the English Channel. The mean temperature of the surface water for the year is above 10°, that for the month of August above 13°, and that of February above 6° C. The bottom temperature is above 7° C. Subdivision of this region is unnecessary for our purpose, as the Scandinavian seas in postglacial time never had higher temperature than the northernmost part of this region at present.

The designation of the regions used may be recapitulated:

Arctic region	a
high-arctic subregion	a^h
low-arctic ›	a^l
Boreal region	b
high-boreal subregion	b^h
mid-boreal ›	b^m
low-boreal ›	b^l
Lusitanian region	l
Arctic, boreal, and lusitanian regions together	w

This regional division of the European seas has been used for a classification of the molluscs, brachiopods, and cirripeds encountered in the Swedish late-Quaternary shell beds according to their present distribution (p. 489).

A species occurring from Franz Josef Land to Trondhjem is designated by ab^m, one occurring from Kola Peninsula to Denmark by a^1b, and one from northern Novaya Zemlya to the Mediterranean by abl or w, etc.

Mostly only the northern limit of distribution is of importance; and, in order to simplify the matter, usually only the designation of the northern limit is given, while the range and the southern limit are indicated by x. A species dispersed from the White Sea to Africa is, for instance, designated by a^1x, and one from Lofoten to the Bay of Biscay by b^mx.

Bathymetrical Division of the Coastal Waters of the Scandinavian Seas and Classification of the Molluscs.

The commonly used classification of the marine shallow-water organisms with respect to their bathymetrical distribution is that of EDWARD FORBES, according to which the following zones are distinguished: 1) the littoral zone or the region between the high and low water tidal marks, 2) the laminarian zone extending from the low water tide mark down to 20 or 25 m (10 or 15 fathoms), and 3) the coralline zone extending from 20 or 25 m to 90 or 110 m (50 or 60 fathoms).

For our purpose another classification is necessary, as the great bulk of the late-Quaternary shell beds between Göteborg and Oslo were laid down in the shore line or in very shallow water, in water less than 20 m deep, in spite of the fact that the highest marine limit is 95 m at Göteborg and 221 m at Oslo.

The littoral zone is kept unchanged, but, on grounds that will presently be given, a bathymetrical boundary is laid at a depth of 10 to 12 m. The belt between the low water tide mark and 10 m may be called simply the shallow water zone, and the region outside the 10-meter curve may be designated as the deep water zone. The animals that largely live in the respective belts may be called littoral forms, shallow-forms (s-forms), and deep-forms (d-forms); and, if they are as frequent inside as outside the 10-meter curve, shallow-deep-forms (sd-forms). For practical reasons littoral forms and shallow-forms are here mostly grouped together and labeled shallow-forms.

In the littoral or intertidal belt normally three different facies can be distinguished with regard to the bottom or foundation, viz. 1) rocky facies without, or with but scanty. vegetation, 2) fucoid facies, and 3) sandy facies. Each one of these facies has a fairly characteristic fauna, as the animals, because of their structure, require different substrata. For instance, littoral gastropods require solid or vegetable foundation, while different bivalves require sand in which to burrow. The most typical and common molluscs and cirripeds on rocks and boulders in this belt are *Littorina littorea*, *L. rudis*, *Mytilus edulis*, *Patella*, *Purpura*, *Verruca*, and the probably recent immigrant *Balanus balanoides*. On algae are especially to be found *Littorina obtusata*, *L. littorea*, *Lacuna divaricata*, and *L. pallidula*. In sand occur the burrowing *Cardium edule*, *Tapes*, and *Venus*.

A limit at a depth of 10 to 12 m, besides being appropriate with regard to the shell beds, seems to be natural from the faunistic point of wiew. As far out as 10 to 12 m in the Danish bays and along the Danish coasts the sea bottom is occupied by the Macoma community, so called after its most typical constituent *Macoma baltica* (Petersen, 1914, p. 15; 1918, Pl. 2). As the belt shows great variations in regard to currents, salinity, and temperature and in regard to bottom — which is rocky, sandy, or muddy; is naked or covered with different kinds of vegetation — it naturally presents different faunistic facies; but these do not nullify the unity. In the Macoma community Petersen distinguishes an infauna which is confined to the level sea bottom whether it is sandy or muddy and whose most typical constituent is *Macoma baltica*, and various onfaunas or epifaunas confined to objects on the sea bottom such as boulders, pebbles, shells, plants, or piles. Among molluscs that are particularly characteristic of this belt may be mentioned *Macoma baltica*, *Mytilus edulis*, *Mya*, *Cardium edule*, *Patella*, *Littorina*, and *Rissoa*. The Macoma belt appears to exist also on the coast of Bohuslän, although, as has been mentioned, no direct studies of the faunistic communities have been made there (see, though, Molander).

The faunistic boundary at about 10 m of depth is partly determined by the vertical distribution of the seaweeds, which in its turn is primarily dependent upon the light conditions necessary for the assimilation of carbon dioxide. In the Oslofjorden assimilation of CO_2 by mosses was found by Jönson to discontinue at a depth of 21 or more meters (see Sernander, 1917, p. 119). At a greater depth carbon dioxide was given off and oxygen assimilated.

This lower limit of assimilation of carbon dioxide by mosses about coincides with the lower boundary of the alga vegetation in the fjord which lies at 17 to 27 m. In Puget Sound, in the State of Washington, the lower limit of photosynthesis in red as well as in brown algae is 35 m (GAIL, 1922, p, 192).

The seagrass, *Zostera marina*, which probably plays a greater rôle for the molluscs that form shell beds than do algae, in fairly salt water extends out to about the same depth as does the Macoma community, never being found in Danish waters below a depth of 6 fathoms, or 11 m (OSTENFELD, 1908, pp. 17, 20, 29). It prefers a salinity of 1 to 3 per cent, requires a fairly sheltered locality, thrives on a pure mud or a sandy mud-bottom, and is consequently most frequent in bays and sounds. In this connection the extraordinary importance of the seagrass as food for the animals after its decomposition to fine detritus is of less interest (BOYSEN JENSEN, 1915; BLEGVAD, 1915; PETERSEN, 1918, p. 8; also HUNT, 1925) than its importance during its lifetime in furnishing protection and favorable conditions for getting food in the form of drifting or sessile micro-organisms like algae and sessile diatoms, detritus of the benthos vegetation, or in the form of prey (BLEGVAD, 1915). As a rule the sea grass in living condition does not serve as food for the animals that live on it. A number of animals thus live either on the plant or in the thickets that it forms. Most important among these are *Rissoa*, *Bittium*, *Littorina*, *Lacuna*, *Gibbula cineraria*, *Nassa reticulata*, *Akera bullata*, *Philine*, *Hydrobia*, and *Mytilus edulis*.

While some algae in the Skagerack go down to about 25 m depth, most of them do not go below 10 m (see SERNANDER, 1917, p. 115). *Fucus vesiculosus*, so common in the area, is largely to be found inside the 5-meter curve. The algae occur on rocky and stony bottoms, in exposed and sheltered localities. On or among algae in the shallow water belt a number of molluscs are to be found, such as *Littorina*, *Bittium*, *Rissoa*, *Hydrobia*, *Lacuna*, *Skenea*, *Nassa*, *Anomia*, *Mytilus edulis*, *Saxicava*, etc. *Nacella pellucida* lives exclusively on *Laminaria* (APPELLÖF, 1912, p. 467).

One or two other facies of the shallow water belt should be touched upon. In sounds and other places where the current is strong enough to carry away the finer material, leaving only large fragments of shells, etc., and where the bottom accordingly is hard, *Anomia ephippium*, *Mytilus modiolus*, *Lepidopleurus asellus*, *Tectura virginea*, *Buccinum undatum*, etc., are met with (APPELLÖF 1912, p. 472). On sandy areas with fragments of shells live burrowing forms, such as *Venus*, *Tellina*, *Psammobia*, *Solen*, *Cardium fasciatum*, *Lunatia intermedia*, etc.

In shallow and quiet landlocked bays into which brooks and rivers discharge and which therefore have brackish water and muddy bottom with zostera the fauna is poor. It includes *Hydrobia*, *Rissoa albella*, *R. membranacea*, and *Nassa reticulata*.

Outside the bathymetric curve of 10 to 12 m, in the region here called the deep water belt, the benthos vegetation consists almost solely of small and scattered red and brown algae. The bottom at first is rocky, gravelly, or sandy. Farther out the sand becomes mixed with clay, which increases with depth. At depth the bottom consists of pure clay. This naturally refers to normal conditions, to more or less open waters. Clayey and muddy bottom, of course, can be found at any depth, however insignificant, in landlocked bays into which muddy streams discharge.

The molluscs of the deep water belt constitute a much smaller part of the late-Quaternary shell beds of Scandinavia than do those of the shallow water belt. The faunistic communities on the Swedish coast are little known, but in the Kattegatt PETERSEN (1914, p. 5) distinguishes several communities at the different depths. Among molluscs living in this zone and of importance for the shell beds are *Abra*, *Aporrhais*, *Buccinum*, *Cyprina*, *Neptunea*, *Turritella*, and *Venus gallina*.

The bathymetrical classification made is given in the table on pages 489—495. Such animals as exclusively or preferably live on the shore and inside the depth curve of 10 m are designated as shallow-forms (s-forms), such as preferably live outside the 10-meter curve as deep-forms (d-forms), and such as are equally common inside as outside the depth limit mentioned as shallow-deep-forms (sd-forms). For the division all available information has been used.

Nearly all collecting of marine animals has been done from relatively large-sized boats at some distance from the shore and at depths of at least several meters. Surprisingly little attention has been given to the belt inside the 10-meter curve. Therefore the upper limit of occurrence is frequently stated to lie much too deep. In all probability many molluscs also occur in less depth than is stated in our table. The mollusc fauna on the Swedish west coast has not been systematically studied since the days of SVEN LOVÉN in the eighteen hundred and forties.

Geographical and Bathymetrical Range of the Molluscs, etc. of the Swedish Late-Quaternary Shell Beds.[1]

	Designation Geogr. Bath. range		Northern	Southern	Recorded from depths of meters
			limit of range		
Abra alba Wood	$b^{m}l$	d	Lofoten	Mediterranean	0—190
» *longicallis* Scacchi . .	$b^{m}l$	d	»	»	36—4 380
» *nitida* Müll.	bl	d	Hammerfest	»	6—550
» *prismatica* Mont. . .	bl	d	»	»	5—180
Aclis supranitida Wood .	$b^{l}l$	d	Bergen	»	15—70
Actaeon tornatilis L. . . .	$b^{m}l$	d	Lofoten	»	5—180
Alvania cimicoides Forb. .	bl	d	Hammerfest	»	4—1 475
» *lactea* Mich.	$b^{l}l$	s	Bohuslän	»	0—a few
» *punctura* Mont. . .	bl	d	Vestfinnmark	Canary Is.	0—235
» *reticulata* Mont. .	$b^{l}l$	d	Bergen	Mediterranean	15—90
» *zetlandica* Mont. .	$b^{m}l$	d	Lofoten	»	22—1 825
Amauropsis islandica Gmel.	ab	d	Circumpolar Regions	Belgium	8—1 267
Anomia aculeata L.	$a^{l}bl$	sd	White Sea	Cape Verd	0—1 950
» *ephippium* L. . . .	$a^{l}bl$	sd	» (Kara Sea, Spitsbergen)	»	0—2 600
» *patelliformis* L. *striata* Brocchi .	$b^{m}l$	d	Lofoten	Mediterranean	0—90
Aporrhais pes pelicani . .	bl	d	Vannöy (70° 10′N.; 20°E.)	»	0—180
Arca glacialis Gray	a	d	Circumpolar R.	Finnmark	5—many
Arcinella plicata Mont. . .	$b^{m}l$	d	Lofoten	Canary Is.	10—1 130
Astarte borealis Chem. . . .	ab^{h}	d	Circumpolar R.	Lofoten (Kiel)	0—463
» *elliptica* Brown . .	ab	d	»	France	5—320
» *montagui* Dillwyn	ab	d	»	Bay of Biscay	3—445
» *sulcata* da Costa .	$a^{l}bl$	d	W. Murman	Canary Is.	10—1 800
Atys utriculus Brocchi . .	$b^{l}l$	d	Bergen, Oslo	»	35—155
Axinus flexuosus Mont. . .	w	d	Spitsbergen	»	2—1 200
» *sarsi* Phil.	b?	d	Vadsö?	Oslofjorden	110—540

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[1] As for modern occurrence or absence in Bohuslän see Antevs, 1917, p. 415.
I am indebted to my Norwegian friends Lektor Olav Kårstad and Docent Birger Bergerson for information regarding the modern spelling and mode of writing of Norwegian geographical names.

	Designation		Northern	Southern	Recorded from depths of meters
	Geogr.	Bath. range	limit of range		
Balanus balanoides L. . . .	a^lb	sd	White Sea	Portugal	0—90
» *crenatus* Brug. . .	w	sd	Spitsbergen	Mediterranean	0—90
» *hameri* Asc. . . .	a^lb	d	White Sea	Holland	0—300
» *porcatus* da Costa	ab	d	Franz Josef Land	Engl. Channel	2—270
Bela decussata Couth. . . .	ab^h	d	Spitsbergen	N of Shetland	16—1 008
» *harpularia* Couth. . .	ab^m	d	Kara Sea	Kristiansund	10—660
pyramidalis Ström . .	ab^h	sd	Spitsbergen	Lofoten	3—707
» *rugulata* Troschel . .	ab^m	d	»	Oslofjorden	5—400
» *trevelyana* Turt. . . .	a^lb	d	White Sea	B. of Biscay	10—860
Bittium reticulatum da Costa	b^ll	sd	Trondhjem	Canary Is.	0—125
Boreochiton marmoreus Fabr.	ab	sd	Circumpolar R	British Is.	0—180
» *ruber* Lowe . .	ab	d	«	Portugal	0—145
Buccinum finmarkianum Verkr. . . .	a^l	d	Kara Sea	Tromsö	60—400
» *groenlandicum* Chem.	a	sd	»	» (Öresund)	0—392
» *undatum* L.	ab	d	Spitsbergen	B. of Biscay	0—1 500
Callochiton laevis Penn. . .	b^ll	d	Boknfjorden	Mediterranean	18—55
Capulus glacialis, only . .			known fossil		
» *hungaricus* L. . .	bl	d	Hammerfest	Mediterranean	0—1 800
Cardium echinatum L. . .	bl	d	Kvænangen	Canary Is.	0—145
» *edule* L.	bl	s	Öksfj. (70° 15′N., 22° 20′E.; Kola)	»	0—10
» *exiguum* Gmel. . .	bl	sd	Öksfjorden	Mediterranean	1—55
» *fasciatum* Mont. .	a^lbl	d	Murman	Canary Is.	10—1 440
» *minimum* Phil. .	bl	d	Vadsö	N. Africa	10—2 590
» *nodosum* Turt. . .	bl	d	Hammerfest	Mediterranean	10—180
» *norvegicum* Speng.	b^ll	d	Trondhjemsfj.	Madeira	9—145
Cerithiopsis tubercularis Mont.	b^ll	sd	Kristiansund	Canary Is.	2—110
Chiton hanleyi Bean	bl	d	Varangerfj.	Mediterranean	18—540
Cingula castanea Möll. . .	a	d	Franz Josef L.	Vadsö	6—216
» *soluta* Phil.	b^ll	?	Bergen	Mediterranean	?
Clathurella leufroyi Mich. .	b^ll	d	Trondhjemsfj.	Canary Is.	5—110
» *linearis* Mont. .	bl	d	Hammerfest	»	5—145
Coecum glabrum Mont. . .	b^ll	d	Boknfj., Oslofj.	»	7—90
Conulus millegranus Phil. .	b^ml	d	Lofoten	Mediterranean	5—180
Corbula gibba Olivi	bl	sd	Hammerfest	Canary Is.	1—180

	Designation Geogr. range	Designation Bath. range	Northern limit of range	Southern limit of range	Recorded from depths of meters
Crania anomala Müll.	bl	d	Vadsö	Mediterranean	15—450
Craspedochilus marginatus Penn.	bl	s	Tromsö	»	0—70
Crenella decussata Mont.	w	sd	Circumpolar R.	»	3—1 140
Cultellus pellicidus Penn.	$b^{m}l$	d	Hillesöy (W. of Tromsö)	»	7—150
Cyamium minutum Fabr.	$a^{l}bl$	sd	Spitsbergen	»	0—45
Cylichna alba Brown.	ab	d	Circumpolar R.	Azores Is.	1—2 433
Cyprina islandica L.	$a^{l}b$	d	White Sea.	B. of Biscay	0—125
Dentalium entale L.	$a^{l}bl$	d	E. Murman	Canary Is.	4—790
» *striolatum* Stimps.	w	d	Spitsbergen	Cape Verd	55—3 150
Diaphana expansa Jeffr.	b	d	Hammerfest	British Is.	0—125
» *hyalina* Turt.	w	d	Spitsbergen	Canary Is.	2—325
Donax vittatus da Costa	$b^{l}l$	sd	Aberdeen, Skagen	Mediterranean	0—27
Dosinia exoleta L.	$b^{m}l$	sd	Lofoten	»	0—70
Emarginula crassa Sow.	$b^{m}l$	d	»	B. of Biscay	18—1 125
» *fissura* L.	bl	sd	Hammerfest	Canary Is.	0—180
Eulima bilineata Ald.	bl	d	Vadsö	Mediterranean	2—540
» *distorta* Desh.	$b^{m}l$	d	Lofoten	»	2—540
» *polita* L.	$b^{l}l$	d	Sognefj., Oslofj.	»	4—145
Eulimella acicula Phil.	$b^{l}l$	d	Sognefjorden	»	18—70
» *ventricosa* Forb.	$b^{m}l$	d	Lofoten	»	18—2 160
Gibbula cineraria L.	bl	sd	Vardö	»	0—110
» *tumida* Mont.	$a^{l}bl$	d	Murman	»	5—180
Hinnites pusio L.	$b^{l}l$	d	Trondhjemsfj.	Canary Is.	0—160
Homalogyra atomus Phil.	bl(?)	s	Vadsö(?)	Mediterranean	0—18
Hydrobia minuta Totten	b	s	Vadsö	Bohuslän	0—2
» *ulvae* Penn.	$a^{l}bl$	s	Novaya Zemlya	Madeira	0—7
Isocardia cor L.	$b^{l}l$	d	Sognefj., Oslofj.	Mediterranean	7—145
Jeffreysia opalina Jeffr.	$b^{l}l$	s	Bergen	»	0—a few
Kellia lactea Brown	b	d	Öksfjorden	British Is.	18—35
» *suborbicularis* Mont.	bl	d	Hillesöy	Cape Verd	0—1 450
Lacuna divaricata Fabr.	$a^{l}bl$	s	White Sea	B. of Biscay	0—100
» *pallidula* da Costa	$a^{l}bl$	s	Spitsbergen	Portugal	0—18
» *puteolus* Turt.	$b^{l}l$	s	Bohuslän	C. Finisterre	0—18
Lasaea rubra Mont.	$b^{l}l$	sd	Kristiansund	Canary Is.	0—1 600
Leda minuta Müll.	ab	d	Circumpolar R.	Britany	4—360

	Designation Geogr.	Bath. range	Northern	Southern	Recorded from depths of meters
			limit of range		
Leda pernula Müll.	ab	d	Circumpolar R.	B. of Biscay	4—960
Lepeta caeca Müll.	ab	d	»	Azores Is.	9—1 287
» *fulva* Müll.	a^{l}bl	d	W. Murman	B. of Biscay	13—1 170
Lepidopleurus asellus L.	bl	d	Vadsö	Mediterranean	0—270
» *cancellatus* Sow.	bl	d	Hammerfest	»	9—430
Lepton nitidum Turt.	b^{l}l	d	Bergen, Oslofj.	»	18—160
» *squamosum* Mont.	l	d	Anglesey, E. Sussex	»	14—35
Lima loscombi Sow.	b^{m}l	d	Lofoten	Cape Verd	9—2 600
Littorina littorea L.	a^{l}bl	s	White Sea	Gibraltar	0—55
» *obtusata* L.	a^{l}bl	s	W of N. Zemlya	Mediterranean	0—55
» *palliata* Say.	a^{l}bh	s	White Sea	Tromsö	0—5
» *rudis* Maton	a^{l}bl	s	Spitsbergen	Mediterranean	0—50
Lophyrus albus L.	ab	d	Circumpolar R.	British Is.	3—600
Lucina borealis L.	bl	d	Vadsö	Mediterranean	0—250
» *spinifera* Mont.	b^{l}l	d	Trondhjemsfj.	Canary Is.	15—160
Lucinopsis undata Penn.	bl	d	Vestfinnmark	Mediterranean	5—180
Lunatia groenlandica Beck.	ab	d	Spitsbergen	Ostende	4—2 300
» *intermedia* Phil.	b^{m}l	sd	Lofoten	Mediterranean	0—145
» *montagui* Forb.	bl	d	Hammerfest	»	2—450
Lyonsia norvegica Chemn.	b^{m}l	d	Lofoten	»	7—1 540
Macoma baltica L.	a^{l}bl	s	Kolguev I.	Madeira	0—360
» *calcaria* Chemn.	ab^{m}	d	Circumpolar R.	Kiel	2—540
» *fabula* Gronov.	b^{m}l	d	Hillesöy	Mediterranean	0—540
» *tenuis* da Costa	bl	s	Vestfinnmark	»	0—18
Mactra elliptica Brown.	a^{l}b	d	E. Murman	Cadiz	10—540
» *subtruncata* da Costa	bl	sd	Varangerfj.	Canary Is.	0—110
Mangelia brachystoma Phil.	b^{l}l	d	Kristiansund	Mediterranean	14—270
» *costata* Don.	b^{l}l	sd	Oslofjorden	»	0—180
Margarita cinerea Couth.	ab	d	Circumpolar R.	61° 40′ N.	1—1 270
» *groenlandica* Chemn.	ab	d	»	British Is.	0—360
» *helicina* Fabr.	ab	d	»	»	0—386
Modiolaria corrugata Stimps.	a	sd	Franz Josef L.	Tromsö	3—287
» *discors* L	bl	sd	Vadsö	Mediterranean	0—18
» *discors v. laevigata* Gray	a	sd	Circumpolar R.	Lofoten	2—374
» *marmorata* Forb.	b^{l}l	d	Trondhjemsfj.	Canary Is.	4—1 040

	Designation Geogr.	Bath. range	Northern limit of range	Southern limit of range	Recorded from depths of meters
Moelleria costulata Möll. .	ab	d	Franz Josef L.	Morocco	9—1 960
Montacuta bidentata Mont.	bl	d	Hammerfest	Madeira	2—180
» *maltzani* Verkr.	a	d	Spitsbergen	Vadsö	18—90
» *substriata* Mont.	bl	d	Vestfinnmark	Mediterranean	9—1 390
» *voeringii* Friele	l	d	Engl. Channel	»	160—1 300
Mya arenaria L.	alb	s	White Sea	B. of Biscay	0-several
» *truncata* L.	w	sd	Circumpolar R.	»	0—623
Mytilus edulis L.	albl	s	Novaya Zemlya	Madeira	0—135
» *modiolus* L. . . .	alb	sd	Kara Sea	Brittany	0—180
Nacella pellucida L.	albl	sd	W. Murman	Mediterranean	0—70
Nassa incrassata Ström. . .	bl	sd	Hammerfest	Canary Is.	0—110
» *pygmaea* Lam. . . .	bll	d	Norw. W. Coast	Mediterranean	9—36
» *reticulata* L.	bll	sd	Trondhjemsfj.	»	0—35
Natica affinis Gmel. . . .	w	d	Circumpolar R.	»	0—2 550
Neptunea despecta L. . . .	abm	d	»	Portugal	0—1 200
Nucula nucleus L.	bml	d	Lofoten	Mediterranean	5—180
» *sulcata* Brown . . .	bll	d	Oslofjorden	Canary Is.	20—180
» *tenuis* Mont. . . .	w	d	Circumpolar R.	Mediterranean	2—1 200
» *tumidula* Malm . .	bl	d	Hammerfest	Morocco	35—2 630
Odostomia albella Lovén .	bll	sd	Bergen	Mediterranean	0—70
» *conoidea* Brocchi	bll	d	Boknfj., Oslofj.	Canary Is.	45—180
» *rissoides* Hanl. .	bll	sd	Bergen, Oslofj.	»	2—180
» *turrita* Hanl. . .	bl	sd	Östfinnmark	»	0—100
» *unidentata* Mont.	albl	sd	Spitsbergen	»	0—180
Onoba aculeus Gould » *striata* Mont. . . .	albl	s	»	»	0—1 170
» *vitrea* Mont.	bll	d	Norw. V. Coast	Mediterranean	9—18
Ostrea edulis L.	bll	sd	Tjötta 66° N.	»	0—80
Panopea norvegica Speng. .	alb	d	White Sea	Kattegatt	45—540
Parthenia interstincta Mont.	bml	d	Lofoten	Canary Is.	0—90
» *spiralis* Mont. .	bl	d	Öksfjorden	Mediterranean	0—1 250
Patella vulgata L.	b	s	Vannöy	British Is.	0—27
Pecten islandicus Müll. . .	abh	d	Spitsbergen	Trondhjemsfj. (Öresund)	9—320
» *opercularis* L. . . .	bml	d	Lofoten	Madeira	0—180
» *septemradiatus* Müll.	bl	d	Vadsö	Canary Is.	10—1 900
» *tigrinus* Müll. . . .	bl	d	Varangerfj.	Spain	0—540

	Designation Geogr.	Bath. range	Northern	Southern	Recorded from depths of meters
			limit of range		
Pecten varius L.	b^{l}l	sd	Trondhjemsfj.	Canary Is.	0—70
Philine aperta L.	b^{l}l	d	Norw. W. Coast	»	9—55
» *quadrata* Wood. . .	a^{l}bl	d	Murman	Azores Is.	5—1 925
Pholas candida L.	b^{l}l	s	Scotld., Skagen (Trondhjem)	Mediterranean	0—15
Pleurobranchus plumula Mont.	bl	s	Vestfinnmark	»	2—270
Portlandia arctica Gray . .	ah	sd	Circumpolar R.	White Sea	4—220
» *frigida* Torell . .	w	d	»	Mediterranean	5—2 420
» *intermedia* M. Sars	w	d	»	Portugal	45—400
» *lenticula* Fabr. .	w	d	Spitsbergen	Morocco	0—1 160
» *tenuis* Phil. . . .	bml	d	Lofoten	Mediterranean	18—2 450
Psammobia ferroeensis Chemn.	bl	d	Vestfinnmark	Canary Is.	9—160
» *vespertina* Chemn.	l	s	Scotld. (Bergen)	»	2—18
Ptisanula limnoides			Not described	Not described	
Puncturella noachina L. . .	ab	d	Franz Josef L.	Portugal	5—2 020
Purpura lapillus L.	a^{l}b	s	Östfinnmark	British Is.	0—27
Rhynchonella psittacea Chemn.	a	d	Circumpolar R.	Tromsö	1—110
Rissoa albella Lovén . . .	b^{l}l	s	Trondhjemsfj.	Mediterranean	0—18
» *inconspicua* Ald. . .	bl	sd	Hillesöy	Canary Is.	2—18
» *interrupta* Ad. . . .	a^{l}bl	sd	Murman	»	0—3 180
» *membranacea* Ad. . .	bml	s	Vesterålen	»	0—1 000
» *parva* da Costa . .	b^{l}l	sd	Nordfjorden	»	0—20
» *violacea* Desn. . . .	bml	sd	Lofoten	Mediterranean	0—70
Saxicava arctica L.	w(a)	sd	Circumpolar R.	Canary Is.	0—1 290
Scalaria communis Lam. . .	b^{l}l	d	Bergen, Oslofj.	»	15—70
Scrobicularia piperata Bell.	b^{l}l	s	» Bohuslän	Mediterranean	0—10
Sipho togatus Mörch . . .	ah	d	Franz Josef L.	Murman	5—1 200
Siphonodentalium lobatum Sow.	abh	d	Circumpolar R.	Portugal	5—3 150
Siphonentalis lofotensis M. Sars	bl	d	Hammerfest	Mediterranean	50—3 150
Skenea planorbis Fabr. . .	w	s	Spitsbergen	Madeira	0—35
Solecurtus antiquatus Pult.	l	d	Shetland Is.	Canary Is.	7—100
Solen ensis L.	bl	sd	Öksfjorden	Mediterranean	0—75
» *siliqua* L.	b^{l}l	s	Bergen	»	0—22
Spirialis retroversus Flem. .	bl	s	Vestfinnmark	Canary Is.	0—9
Tapes aureus Gmel.	b^{l}l	sd	Bergen, Oslofj.	Mediterranean	0—35
» *decussatus* L.	l	s	Shetl. Is. (Nordfj.)	»	0—35

	Designation Geogr. range	Designation Bath. range	Northern limit of range	Southern limit of range	Recorded from depths of meters
Tapes pullastra Mont. . . .	bl	s	Hammerfest	Mediterranean	0—35
» *virgineus* L.	bll	sd	Nordfjorden	»	0—325
Tectura rubella Fabr. . . .	a	sd	Circumpolar R.	Tromsö	0—540
» *virginea* Müll. . .	albl	sd	Murman	Canary Is.	0—180
Tellimya ferruginosa Mont.	bl	d	Vestfinnmark	Madeira	13—150
Tellina crassa Gmel. . . .	bll	sd	Trondhjemsfj.	Mediterranean	0—90
» *pusilla* Phil	bml	d	Lofoten	»	0—90
Terebratulina caput serpentis L. . . .	albl	d	Murman	Cape Verd	0—2 125
» *septentrionalis* Couth. . .	a	d	Circumpolar R.	Hammerfest	18—1 200
Thracia papyracea Poli . .	bml	sd	Lofoten	Canary Is.	0—110
» *truncata* Brown . .	abm	sd	Circumpolar R.	Bergen	3—360
» *villosiuscula* Macg.	bmbl	sd	Lofoten	British Is.	0—60
Trichotropis borealis Brod. & Sow.	ab	d	Siberian Sea	Denmark	17—944
Triforis perversa L.	bll	sd	Sognefj., Oslofj.	Canary Is.	0—125
Trivia europaea Mont. . . .	bll	sd	Trondhjemsfj.	Mediterranean	0—180
Trophon clathratus L. . . .	abm	d	Circumpolar R.	Bohuslän	3—1 960
» *truncatus* Ström .	abm	d	Spitsbergen	France	3—954
Turbonilla indistincta Mont.	bll	d	Bergen, Oslofj.	Canary Is.	7—90
» *lactea* L.	bll	sd	Bergen	Mediterranean	0—90
Turritella terebra L. . . .	bml	d	Lofoten	»	5—180
Utriculus mammillatus Phil.	bll	d	Boknfj., Oslofj.	»	5—110
» *obtusus* Turt. . .	bl	sd	Vadsö	»	0—27
» *pertenuis* Migh. .	a	d	Circumpolar R.	Tromsö	18—265
» *truncatulus* Brug.	bl	sd	Vestfinnmark	Mediterranean	2—145
» *umbilicatus* Mont.	bml	d	Lofoten	»	18—540
Velutina laevigata Penn. .	w	sd	Franz Josef L.	»	1—950
Venus fasciata Don.	bml	d	Ranfjorden	»	0—100
» *gallina* L.	bl	sd	Vadsö	»	0—180
» *ovata* Penn.	bl	sd	»	»	0—2 380
Verruca stroemia L.	albl	sd	E. Murman	Red Sea	0—540
Vola maxima L.	bll	d	Halten (64° N.)	Mediterranean	0—145
Volutopsis norvegica Chemn.	abh	d	Cricumpolar R.	Lofoten	20—650
Waldheimia cranium Müll.	w	d	»	Cape Bojador	18—1 870
Yoldia hyperborea Lovén .	a	d	»	Lofoten	3—675
Zirphaea crispata L. . . .	alb	s	White Sea	British Is. »	0—36

II. Formation of Shell Beds and Associated Clay Layers.

In the extensive literature on late-Quaternary marine shell beds the mode of formation of shell deposits has been given some, though insufficient, attention.

Brögger (1901, pp. 71, 221, 357, 393, 473) thinks that the raised shell beds in southeastern Norway were deposited in depths of from about 2 to 10 or more meters and the shelly clays in depths of 15 to 40 meters.

The Danish zoologist Johansen (1901) seems to be the only one who has carried out direct studies on the formation of shell beds. On the basis of studies of a great number of littoral beds on the shores of the Kattegatt, the west coast of Jylland, the Faeroe Islands, and Iceland and of dredgings on depths of from 25 to 100 m off the coasts of Iceland Johansen sums up his views as follows:

»1. The shells of molluscs are only partly deposited inside the vertical area of distribution of the respective species.

(2. On deposition of shell beds in lakes.)

3. In the sea there is along the open coast a belt of displacement from which the waves carry a number of the shells upward or downward and in connection with currents cause the formation of upwashed shell beds and downwashed shell beds.

4. Upwashed shell beds occur either on the shore or in quite small bays near the shore below the sea level. They can contain shells of all forms that live from the shore down to a depth of about 15 m (except in small inland seas or in fjords).

5. The position of the downwashed shell beds (Skaldynger) is largely dependent on the steepness of the coasts. These beds can be met with at from 15 to 20 m depth down into the abyssal region. Their faunas are heterogeneous, consisting of representatives of different biological groups. Littoral forms (*Littorina*, etc.) are present only in subordinate numbers.

6. A different type are the beds (Skalbanker) whose shells are essentially derived from animals that lived on the spot. They are to be found from the belt of displacement to the upper limit of the abyssal region and are particularly developed on elevations and gently sloping parts of the sea bottom with sand or clayey sand.

7. The shell accumulations in the shell beds (»Skalbankerne»)

from the raised deposits in Scandinavia are upwashed shell beds (Skaldynger). The molluscs represented, which in all probability lived outside the 15-meter curve, may have been washed ashore after the sea bottom began to rise.

8. The young of molluscs frequently have a rather different vertical distribution from that of grown animals. Shells of small young outside the vertical area of distribution of grown animals therefore need not have been transported there.»

De Geer (1910, pp. 1153—1156) holds that the bulk of the shells in the raised shell beds in Bohuslän are derived from animals that lived on the spot. However, downwashing of shells from rock ledges took place. Normally the downwashed shells may have settled at the foot of the cliffs, as the numerous islands and peninsulas may have prevented transportation by waves and currents. Upwashing of shells may not have taken place in Bohuslän. When the shell beds were uplifted above sea level, streams may have transported shells down to the sea, where they were deposited for a second time and eventually mixed with shells of a later date (also p. 536).

Halden (1917, pp. 7, 180; 1920), who has studied raised shell beds especially in the region of the Gulf of Bothnia, observes that they almost exclusively occur on the slopes of hills and in depressions immediately below elevations. A broken topography with islands, bays, and coves is a requirement for the formation of shell accumulations. By waves and breakers the shells were washed down from the shore and shallow water to depths varying from a few meters to several tens of meters. The shell beds are thus allochthonous. Changes in the coarseness of the material may be due to changes in the conditions of sedimentation. The beds are frequently overlain by clay layers which, judging from their plant fossils and greatly varying height above the sea, are derived from very different ages.

Antevs (1917) thinks that the late-Quaternary shell beds on the Swedish west coast are composed of shells deriving from animals that lived on the spot as well as from animals washed down from neighbouring elevations. The relative rôle of local and downwashed shells depends largely on the topographic conditions.

Odhner (1918, pp. 206, 218, 227—230) holds, in direct opposition to Halden and Sandegren, that the shell beds are essentially autochthonous, formed of shells of animals living on the spot. Furthermore, they were formed during regression. Downwashing of shells from elevations played no rôle, but redeposition did. The concentration of living animals on certain spots, necessary for the formation of shell beds, may have been favored by rotation currents. The clay layers accompanying many shell beds were largely deposited in shallow water as the bays and sounds became more enclosed during the rise of the land. Lately, ODHNER (1927, p. 81) has adopted HALDEN's and SANDEGREN's view.

SANDEGREN (1924, p. 161; 1926, p. 79) states that the raised shell beds occur immediately below steep elevations, in small basins on the hillsides, and at the pass points in narrow glens. He agrees with HALDEN that they were formed in more or less deep water allochthonously, by enrichment of shells washed down from raised shelly deposits torn up by the surf and of shells derived from the fauna living in the vicinity during the time of formation. The formation may have taken place largely during regression; and the shells by repeated redeposition were gradually carried farther and farther down, until they reached places from where further downward transportation was not possible. As a consequence of this downwashing the shell beds finally contained shells of very different ages and from very different depths and bottoms. Consequently the shell beds can hardly be used for a study of the time of immigration of the molluscs, the changes of level, etc.

Mrs. CLEVE-EULER (1926, pp. 330—334) thinks that the large shell beds on the shores of the Skagerack were normally formed in situ. When the accumulation started depth, salinity, exposure, vegetation, proportion of oxygen, etc. no doubt were highly favorable for a certain fauna. However, if the relation of land and sea remained unchanged, the accumulation of shells must have altered the conditions so that they became unfavorable and caused a gradual change of the faunistic composition. Therefore thick beds with a uniform fauna must mean that the environment of the molluscs did not change appreciably and that transgression and growth of the shell beds proceeded at the same rate. Transgression is necessary for the formation of thick shell beds. The bulk of the shell beds may be derived from transgressions.

Each one of these advocated modes of formation holds for a greater or less number of cases but not for all cases, unless those of JOHANSEN cover them all. Before proceeding to the discussion of the problems, certain observations on some shell beds now forming under different conditions on the Swedish west coast may be made.

Description of beds under formation.

Littoral beds.

Smalsundet.

Table p. 664.

Smalsundet is the sound immediately west of Kristineberg Marine Zoölogical Station 1 km west of Fiskebäckskil, between Skaftölandet and Blåbärsholmen. It runs in south-west and northeast. It is narrowest in the outermost part, where it is 100 m wide. Some small rock ledges occur in the center of the sound here; and here it also is shallowest, from one-half to a few meters deep; at one point there is a ford less than 1 m deep. It is the shallow part, dotted on the chart, that is of immediate interest here. Studied August 8, 1919.

In the center of the sound there is a dense thicket of zostera on a sand bottom with a mat of dead zostera. On the sides there are relatively vegetation-free zones of fine sand with scattered shells that grow more frequent nearer the land. On the north side shelly sand begins some 20 m from the shore. The percentage of the shells increases landward, and at high water mark there lies a ridge of shell gravel practically free from stones in which *Littorina* dominates and *Mytilus* is numerous and *Mya arenaria* less numerous. During storms particularly light shells and fragments have been thrown some decimeters above the sea level. The thickness of the shell gravel in the shore line probably is considerable, in any case more than 1 m. The richest shell gravel occurs somewhat north of the innermost rock where the water becomes more quiet. Around the small rocks in the sound shell gravel or shelly sand is accumulated, especially on the lee side, or the northeast side.

On the south side of the zostera thicket that occurs in the center of the sound the conditions are somewhat different, because the current caused by the rise and fall of the tide water or by storms follows the south shore. Near the zostera thicket there is sand bottom without vegetation but with scattered shells especially of *Cardium edule* and *Mya*. Near land the bottom consists of stones some centimeters in diameter. Among the pebbles lie heavy shells of *Ostrea*, etc. In a little bay somewhat east of the rocks, where the current is weak, a poor shell gravel is being deposited.

The shallowing up of the Smalsundet by deposition of sand and shell gravel has proceeded very rapidly, for, being now hardly 1 m deep, the sound one hundred years ago was so deep that large vessels could pass through it.

Samples of the shell gravel were taken in a quiet bay on the southern side some 20 m from the shore — Smalsundet A, at the southern shore — Smalsundet B, and on the northern side of the sound — Smalsundet C.

Smalsundet A. — Some 20 m from the southern shore and on a depth of 1 m. About one-third of the material consists of pebbles of varying size.

Smalsundet B. — Near the shore and on a depth of 0.5 m. The shell gravel consists in reality of pebbles some centimeters in size, and of shell fragments.

The samples A and B may be treated contemporaneously. The molluscs and their frequency are given in the tables on page 664. Where did the molluscs occurring in the gravel live? With the exception of *Ostrea* the shells give the impression of being fully modern. As far as known the oyster has not lived in the sound during recent decades, and transportation of the heavy shells about 1 km from the Bökevik, the little bay just west of Fiskebäckskil where the species is living on hard sand bottom and at a depth of 1 to 1.5 m, is probably out of the question. The fauna contains 12 forms preferably living inside the 10-meter curve (shallow-forms, s-forms), 7 species preferably occurring outside the depth curve of 10 m (deep-forms, d-forms), and 20 species equally common inside and outside the 10-meter curve (shallow-deep-forms, sd-forms). The bulk of the material is derived from molluscs that are common in shallow water. The majority of the individuals may even have lived on the spot or in the immediate neighbourhood, especially in the zostera thicket, for with one or two exceptions the s-forms and the sd-forms were observed in the sound or can be assumed to occur there, on account of their general occurrence. The exceptions are *Ostrea*, already mentioned, *Tapes aureus*, and *Scrobicularia*. *Tapes aureus* was found by THÉEL (1907, p. 86) in Långgapshålet 0.5 km north of the shell bed, so that the species perhaps also occurs in the Smalsundet. *Scrobicularia* is not included in THÉEL's list, perhaps because of the fact that dredgings are only exceptionally carried out in such quiet and shallow bays with weak salinity as those in which the form is preferably living.

The d-forms are *Abra*, *Alvania punctura*, *Anomia striata*, *Balanus porcatus*, *Lucina borealis*, *Montacuta bidentata*, and *Parthenia spiralis*. They are all represented by a small number of individuals or by fragments. All of them can be found in very shallow water though they prefer water of some depth. Probably part of the d-forms have been transported from some depth and a shorter or longer distance. The shells can either have come from the northeast or from the fjord outside, the Gåsöredd. Some of them are possibly redeposited, post-glacial.

Smalsundet C. — The north side of the sound, north of the innermost rock, in the shore line. As has been mentioned, shell gravel occurs out to about 20 m from the shore. Practically stone-free gravel is thrown up into a little ridge in the highwater line and a few decimeters above.

The majority of the species, and especially those frequently represented, live on the very shell bed or in its immediate neighbourhood, above all in the zostera thicket. The composition of the fauna is 15 s-forms, 24 sd-forms, and 3 d-forms. The latter ones are *Balanus porcatus*, *Clathurella linearis*, and *Lepidopleurus asellus*. Of these *Lepidopleurus* can live in the shore line. The shells of the other two have probably been transported some distance.

The mode of formation of the shell beds evidently is the same on both sides of the sound. A large part of the animals lived on the very spot. The majority of the other molluscs lived in the immediate neighbourhood from where the empty shells have been transported by currents and waves. Shells of a small number of species have been washed up from some depth and have been transported a shorter or longer distance. The shells are accumulated in quiet places from where they cannot be transported under prevailing conditions. At Smalsundet A and B the accumulation is entirely under the water surface, at Smalsundet C it is partly below, partly above. The transportation of the bivalves has been made possible by the great surface of attack they offer, and that of gastropods may have been facilitated by the formation of gases on the decay of the dead animals. Some shells may have drifted in with seaweed.

Kristineberg II.

Table p. 664.

0.8 km W of Fiskebäckskil, the bay SSE of Kristineberg Marine Zoölogical Station, August 8, 1917 and August 8, 1919.

The shell bed occurs at the end of the shallow and shelving bay and extends from a few tens of meters outside the shore to a few tens of meters up the flat shore. Close by the east side a rock rises perpendicularly about ten meters and, after a shelf, still higher. This rock has had no influence upon the formation of the shell bed by being a substratum for an appreciable percentage of the molluscs, for the older part of the bed, now lying above sea level, was clearly formed in the same way as shell gravel is now being accumulated in the shore line.

In the bed five samples were taken, vis. A 0.75 m above sea level; B 0.6 m; C at the storm line 0.3 m; D 0,1 m above sea level; and E at the high-water mark. Of these C to E are fully modern. At A the thickness of the shell bed is 0.2 m, at C 0.3 m, and at the high-water mark 0.1 m. The substratum consists of shell-free sand.

From the shore to about 200 m out the whole bay has a fine white sand bottom without vegetation. The depth of the water is 0.5 to 1 m. Outside this belt the depth increases abruptly and a dense zostera thicket begins. Trawling on depths of from 3 to 5 m, at which, however, the trawl because of the dense vegetation did not reach the bottom, gave the following result: *Rissoa membranacea* 65 individuals, *R. violacea* 45, *R. albella* 2, *Bittium* 1, *Littorina rudis* 1, and *Nassa reticulata* 1. From the zostera belt to about 50 m from land the sand bottom contains but relatively few living animals and only scattered empty shells. By trawling, many living specimens of *Littorina littorea*, several specimens of *Nassa reticulata*, and a few ones of *Mytilus edulis* were obtained, and also empty shells of *Cardium edule* and *Mya arenaria*. About 50 m from the shore the sand becomes shell-bearing with an increasing percentage of shells toward the shore. The shells largely consist of fragments. Some forms, as *Cardium edule*, *Littorina littorea*, and *Nassa reticulata*, live on the spot. In the shell gravel accumulated in the very high-water line *Littorina littorea* and *Cardium edule* are particularly noticeable. This shell gravel, washed up by the waves, largely consists of complete and large shells that thus are more readily transportable.

The part of the shell bed now under formation contains an outward increasing percentage of pebbles. At the storm line, sample C, stones form an insignificant part; single pebbles are 0.5 cm in diameter. In sample D pebbles form nearly one-third of the material, and in sample E at the water line, more than one-half. The forming shell gravel predominantly consists of species that are found or can be expected to occur at the very shore line, on the sand belt, or in the zostera thicket. *Ostrea* is living in the Bökevik, the little bay a few hundred meters to the east, but

Tapes aureus, which is rather scarce in the Swedish waters, is not known from the vicinity (cf. p. 500).

The composition of the whole fauna is 16 s-forms, 30 sd-forms, and 21 d-forms. The last mentioned are with some exceptions represented by only a few specimens. Most of the d-forms go in on very shallow water, but the following ones are, according to the unsatisfactory records of the vertical range, first met on depths of five or more meters: *Abra nitida, Clathurella linearis*, *Lepeta cæca*, *Lepton nitidum*, *Lophyrus albus*, *Turbonilla indistincta*, and *Turritella*. The shells of these species and many more may have been brought up by waves and currents from the depth of the bay outside, for the outward growth of the bed, among other things, makes it improbable that they are old and occur in secondary position.

Fiskebäckskil II.

Table p. 664.

0.5 km SE of Fiskebäckskil church, the southern side of the eastern branch of the bay, 0.2 m below sea level, August 9, 1919.

The present shell bed, that may be characterized as sand rich in shells, extends as a narrow belt several tens of meters along the rocky sheltered shore. At the very shore it is covered by 2 dm of water. The thickness of the bed is unknown but is surely insignificant.

The fauna of the bed is composed of 10 s-forms and 7 sd-forms. By far the greatest rôle is played by *Littorina littorea-rudis* represented by 44 individuals in one-tenth of a liter of shell sand, *Mya* represented by 5, and *Hydrobia ulvæ* by 115 specimens. The other species are scantily represented or otherwise of little importance. Most of the forms have been observed by the writer living in the bay, and others probably also occur. The *Scrobicularia* shell may very well be modern, but the fragments of *Ostrea* are most probably old. Thus the material of the bed is derived from the immediate neighbourhood. The poverty of individuals and species and the great number of the brackish water form *Hydrobia* make the deposit a typical one for a landlocked bay in which the animal life is altogether too poor for the formation of a real shell bed.

Fiskebäckskil III.

A few hundred meters SSE of Fiskebäckskil church, the southward branch of the bay, August 9, 1919.

The central part of the shallow bay is overgrown with dense zostera extending to within 30 to 5 m of the eastern shore and to within 100 m of the southern shore. The shore belt without vegetation is as much as 0.5 m deep. On exposed places the bottom near the shore consists of cobbles, while shells are accumulated at the high-water mark. Outside as well as at the end of the bay there is fine, somewhat muddy sand with scattered shells. In the zostera belt, where the bottom is uncertain on account of a thick mat of decaying plant remains, no shells could be seen. The shells inside the zostera thicket consist almost exclusively of *Littorina littorea*, *Cardium edule*, and *Mya arenaria*, among which the first-mentioned predominates.

On the western side of the bay, about 200 m south of the church, the depth of the water some 20 m out is about 0.5 m. The bottom consists of fine muddy sand. On the shore line itself shells are fairly frequent. The following ones were identified: *Aporrhais*, *Buccinum undatum*, *Cardium echinatum*, *C. edule*, *Cyprina*, *Littorina littorea*, *Lucina borealis*, *Mya arenaria*, *M. truncata*, *Mytilus edulis*, *Ostrea*, and *Saxicava*. The last-mentioned is represented by large late-glacial shells. Only *Cardium edule*, *Littorina*, *Mya arenaria*, *M. truncata*, and *Mytilus* may be fully modern, while the others, with the exception of *Saxicava*, probably date from the post-glacial time.

Hermanö III.

Table p. 664.

9 km SSW of Fiskebäckskil, 0.8 km S of Gullholmen church, at the path across the bay, at sea level, August 7, 1917.

At the point where the bay is narrowed to about 20 m width, is limited by rather steep rocks 5 to 7 m high, and is almost dry at low water a shell gravel rich in pebbles and sand is deposited. The thickness of the deposit is unknown. The sample was taken in the center of the bay. The modern growth of the shell bed is insignificant, and its formation has with certainty gone on for a long time. It is not improbable that part of the shells are of post-glacial age and now occur in secondary position. As the bed is situated on the inner side of Hermanö, the rise and fall of the tide water may be the essential factor for the renewal and movement of the water that is necessary for a rich animal life and the accumulation of shells.

The composition of the fauna is 13 s-forms, 20 sd-forms, and 7 d-forms. Of the last-mentioned *Balanus porcatus* is numerously represented. However, the bed is predominantly composed of littoral and shallow-water forms common on the west coast. Only *Ostrea* is now infrequent, and the shells of this species are perhaps derived from the post-glacial time. Among deep-forms represented in the bed some go in on very shallow water, while *Astarte elliptica*, *Cardium nodosum*, *Clathurella linearis*, *Mactra elliptica*, and *Nucula nucleus* hardly are met with in water less than five or more meters deep. Whether these latter are modern and have been transported to the spot from the sound inside the island cannot be said, but this is perhaps as probable as the other alternative, namely, that they date from the post-glacial time.

Ålstenshamn II.

Table p. 664.

4 km N of Gravarne, the narrow sound between the mainland and Tryggö, just S of the bifurcation of the sound, 0.4 m above sea level, August 1, 1917.

In the sound mentioned, which at the time of visiting was almost dry but which is flooded at very high water, the following profile was measured in an excavation:

Topmost, 2 dm shell gravel.
0.6 dm peat.
$>$4 dm shell gravel (p. 614).

It is the topmost shell bed that will be considered here. The shell gravel that contains scattered pebbles and much sand may during exceptionally high water have been brought to the place from the outer part of the sound and the neighbouring deep bay, a distance of one hundred to a few hundred meters.

Littoral and shallow forms predominate entirely, deep-forms being represented only by single individuals of *Balanus porcatus* and *Scalaria communis.*

Vik III.

Table p. 664.

2 km S of Bovallstrand, the Vikekilen, the eastern side of the south-western branch, sea level, July 28, 1917.

On the place mentioned shell gravel is being deposited at the water line. The bed is 0.25 m thick and is underlain by sand. The material is very crumbled and rather stony. The number of species is small because of the situation far within a bay so shallow that the depth at 400 m out amounts to only 4 m. For the same reason the bed lacks typical deep-forms, the composition being 3 s-forms and 14 sd-forms. It is possible that at least part of the shells attributed to *Balanus crenatus* belong to *B. balanoides*.

The history of formation of the bed seems to be the same as that of the other beds treated. Some forms have lived on the very spot, others have been transported some distance, until they reached a quiet place.

Vikekilen II.

Table p. 664.

1.2 km SSW of Bovallstrand, the little bay at the northern end of the peninsula, at the high-water mark, July 30, 1917.

At and somewhat outside the shore in the little shallow and shelving bay very stony shell gravel is being deposited. It is about 1 dm thick and rests on gyttja. It is quite predominantly composed of forms that in all probability occur in the immediate vicinity, at the shore, or in the zostera belt just outside. *Ostrea* and *Scrobicularia*, however, cannot without further study be assumed to live in the bay, but they have possibly been redeposited from post-glacial beds. The composition of the fauna is 8 s-forms, 17 sd-forms, and 3 d-forms. The d-forms, *Astarte montagui*, *Clathurella linearis*, *Montacuta bidentata*, are occasionally met with in water of 5 m depth or less. They have probably been transported from some depth, for the local conditions make redeposition from post-glacial beds unlikely.

Vikekilen III.

Table p. 664.

0.8 km S of Bovallstrand, opposite the little valley, the water line, July 27, 1917.

Here a rich shelly gravel is forming between the tidal marks. The fauna consists of 5 s-forms, 14 sd-forms, and 3 d-forms. The predominant species are common in shallow water. The d-forms, *Alvania punctura*, *Astarte montagui* and *Lucina borealis*, are poorly represented. They have probably been washed up from some depth.

Svenneby III.

Table p. 665.

2.2 km NW of Bovallstrand, the inner side of Valön, 0.2 km N of Långö, the high-water line, July 24, 1917.

At this locality a shell gravel rich in pebbles and sand is being deposited on the flat shore of the quiet, shallow, and shelving bay. Two samples, A and B, were taken at some distance from each other. Both samples contain essentially the same species. S-forms are represented by 15, sd-forms by 27, and d-forms by 6 species. The great mass of the shells is derived from species that in all probability have lived and still live on the shore and among the zostera just outside. Of less common molluscs there occur *Ostrea*, *Psammobia*, *Scrobicularia*, and *Tapes aureus*, which, however, are with equal probability either modern or post-glacial. The d-forms, *Anomia striata*, *Aporrhais*, *Balanus porcatus*, *Boreochiton ruber*, *Lucina borealis*, and *Portlandia lenticula*, are represented by single individuals or by fragments. Most of them may be derived from the bay and the fjord outside, and may thus have been transported at least a few hundred meters.

Skarvik.

Table p. 665.

18 km WNW of Göteborg, the west side of Björkön, Skarvik, 100 m NW of the wharf, at the high-water line, June 27, 1917.

The shell gravel occurs at the base of a fairly steep cliff. Somewhat outside the shore line the depth increases rather rapidly. The shell gravel is very stony. The fauna is composed of 7 s-forms, 16 sd-forms, and 8 d-forms. The d-forms, with the exception of *Balanus porcatus*, are poorly represented, and the bulk of the shells are derived from animals that may have lived at the water line and at insignificant depth. Of the d-forms *Astarte elliptica*, *A. montagui*, *Balanus porcatus*, and *Pecten islandicus*, judging from their appearance, are probably derived from a late-glacial deposit, though all of them are now living on the coast. Among species that on the other hand may have been washed up by currents and waves from some depth should be mentioned *Aporrhais* and *Turritella*.

Tromsö.

Tromsö in northern Norway, the eastern side of the Tromsösound, the southern side of the ferry wharf, at the high-water mark, August 4, 1918.

At the place mentioned a large shell bed is being deposited below and above the high-water mark. The material is fairly stony and consists of whole fresh shells as well as of rounded fragments.

Whether all the material is modern or not is difficult to tell. The accumulation of shells is greatly favored by the projecting stone wharf.

In one-tenth liter of shell gravel the following species and numbers were determined:

	Ind.		Ind.
Anomia ephippium	$1^1/_2$	*Macoma baltica*	$1^1/_2$
Astarte borealis	1	*Mya truncata*	2
› *elliptica*	$^1/_2$	*Mytilus edulis*	9
› *montagui*	1	*Pecten islandicus*	$1^1/_2$
Balanus crenatus	50	*Puncturella noachina*	2
Bela trevelyana	1	*Purpura lapillus*	2
Boreochiton ruber	1	*Saxicava arctica*	1
Cardium edule	$^1/_2$	*Tectura rubella*	7
Littorina littorea-rudis	9	› *virginea*	4
› *obtusata*	1	*Trophon clathratus*	1
› *palliata*	1	› *truncatus*	1

The dominating species in the bed is *Balanus crenatus*. *Littorina* and *Mytilus* are also numerous. *Cardium edule* is represented by a large shell and *Saxicava* by very large and thick shells. The fauna is composed of 12 ax-forms, 8 a^{1}x-forms, and 2 bx-forms — *Cardium* and *Purpura;* and of 7 s-forms, 6 sd-forms, and 9 d-forms. The d-forms are represented by few specimens that may have been transported by currents and waves from depths of a few to several meters, unless they occur in secondary position.

Shallow-water beds.

The large number of littoral shell beds and deep-water beds described here and the small number of shallow water beds that will be touched upon should not be taken to mean that these latter are less frequent. The discrepancy in numbers depends essentially upon the fact that littoral beds are easily accessible and that during the writer's visit at Kristineberg Zoölogical Station in August, 1919, dredgings for zoölogical material were largely carried out in fairly deep water. Shell gravel is also deposited in various other situations, as is well shown in earlier dredgings by the station (Théel, 1907, pp. 100—125; and oral information by the dredging master).

Strömsund.

Table p. 665.

5 km SE of Lysekil, N of Bassholmen, the eastern branch at its junction with the north-southerly branch, 4 to 5 m depth, August 20, 1919.

The sound in which the dredging was made is from 15 to 30 m wide, and is limited by fairly steep to precipitous rock cliffs. The current in the sound is very strong. The shell gravel consists of more than 50 per cent of pebbles. It also contains coarse sand but no clay. The shells to a large extent consist of worn fragments.

The sample presents 29 species, or 7 d-forms, 16 sd-forms, and 6 s-forms. Also in regard to individuals the littoral forms play an unexpectedly small rôle. The reason may be that many of them prefer more quiet waters and that others have too light shells to settle.

Ostrea and *Tapes pullastra* were found in living conditions. The d-forms consist partly of species — *Balanus porcatus*, *Mactra elliptica*, *Pecten islandicus*, and *Scalaria communis* — that usually do not occur in so shallow water. It has been pointed out by THÉEL (1907, p. 123) that at this spot several animals occur which are very seldom or never obtained in the Gullmarsfjorden or in the outer skerry guard. The reason is supposed to be the unusually strong current.

Bonden.

Bonden is an island in the seaward skerries 10 km SW of Lysekil. The sea bottom on the inner side of it consists essentially of shell gravel with spots of zostera and algae. The depth of the water does not exceed 25 m. Shell gravel is particularly pure and abundant in depths of from 4 to 10 m. The characteristic forms mentioned by THÉEL are (1907, p. 106): *Astarte montagui*, *Dosinia exoleta*, *Cardium norvegicum*, *Mactra elliptica*, *M. subtruncata* *Montacuta substriata*, *Tellina pusilla*, *Thracia papyracea*, *Venus fasciata*, *V. gallina*, and *V. ovata*. Since common species are not included in the list, no definite opinion as to transportation, etc. can be formed. It is evident, however, that here the essential conditions for accumulation of shells exist, viz. rich nourishment and lively water circulation, and, close by, calm water on the lee side, enabling deposition of the shells.

Plymouth.

In Plymouth Sound, England, shell gravel is forming on many places at depths of from 7 to 15 m (Ford, 1923, pp. 195—197).

Deep-water beds.

Tova and Högarödskären.

Shell gravel is being deposited at a depth of from 10 to 20 m on the northwest side of Tova Island just south of Lysekil. It is also forming on depths of a few tens of meters below the steep Högarödskären, 2.5 km southeast of Lysekil, from molluscs living on the rock cliff (Théel, 1907, pp. 116, 117).

Bärviken.

Table p. 665.

4.5 km ESE of Lysekil, 0.5 km SSE of the southeastern corner of Lindholmen, the little bay S of Bärviken, 15 to 100 m from land, about 15 m depth, August 20, 1919.

The bottom at the place of dredging consists of ill-smelling gyttja and mud with sparse shells and pebbles. The shells are largely fragments. The number of the species found is 28. Of these 12 are d-forms, 13 sd-forms, and 3, viz. *Littorina littorea-rudis*, *Mytilus edulis*, and *Purpura*, are s-forms. The bottom appeared unfavorable, and only *Cultellus* was found in living condition. Thus most of the species may have been transported from elsewhere, probably by currents. This has particular reference to the abundantly represented *Balanus crenatus* and to forms confined to zostera and laminaria.

Lindholmen I.

Table p. 665.

4 km ESE of Lysekil, between the southeastern corner of Lindholmen and the little islet in the sound, about 15 m depth, August 20, 1919.

The sound, which is less than 100 m wide, is limited by steep to perpendicular rock walls. The shell gravel contains but scattered pebbles and, on account of the strong current, no clay. It consists to a fairly large percentage of fragments. Of the 38 species in the sample 15 are d-forms, 21 sd-forms, and 2, viz. *Litto-*

rina littorea and *Onoba striata*, s-forms. The small number of the latter species may be due to the steepness of the rock cliffs and the strength of the current.

In the catch were observed living specimens of *Anomia*, *Buccinum undatum*, *Chiton*, *Gibbula cineraria*, *Mytilus modiolus*, *Nucula*, *Pecten septemradiatus*, *Turritella*, and *Venus ovata*. Beside these, several others may live on the shell bed, while the balanids and the Rissoae may essentially be derived from the bare or alga-covered rock cliffs, and thus may have been washed down without any transportation worth mentioning.

Lindholmen II.

Table p. 665.

About 100 m S of Lindholmen I, 15—20 m depth, August 20, 1919.

The current at this place is less strong than in the narrow sound, so that some clay has been deposited with the shells. The shell gravel contains few pebbles. The fauna naturally agrees in all essentials with that obtained in the other haul. The number of species is 39, of which 16 are d-forms, 21 are sd-forms, and 2 s-forms. *Littorina littorea-rudis* and *Onoba striata* have probably been washed out from shallow water in the immediate vicinity, though they perhaps have partly lived on the spot.

Humlesäcken.

Table p. 665.

1.5 km SW of Lysekil, between Tistholmen and the main land, 25 to 30 m of depth, August 6, 1919.

At trawling in the center of the Humlesäcken a somewhat clayey, very stony shell gravel was brought up. Besides species found in the statistically analyzed sample, the following forms were obtained in a picking from another dredging:

	Ind.		Ind.
Astarte elliptica	3½	*Lyonsia norvegica*	1
Conulus millegranus	13	*Modiolaria marmorata*	1½
Crania anomala	1	*Velutina laevigata*	1
Ditrypa arietina	2	*Venus gallina*	½
Lima loscombi	11		

The shell gravel is characterized by a very great number of species, not less than 68 being identified. Of these 37 are deep-forms and 6 are littoral and shallow-forms, while 25 are equally as frequent inside as outside the ten-meter curve. The shallow-water forms are: *Cardium edule, Lacuna divaricata, Littorina littorea-rudis, Mytilus edulis, Onoba striata*, and *Purpura* and may have been washed down by waves and currents from the shallow shore belt and carried out into the basin. The transportation need only have been one hundred or two hundred meters. The rôle played by the enumerated species in the deposit is secondary and comparable to the rôle of the deep-forms in littoral beds.

In one haul the following empty shells and living animals were obtained:

	Individuals	
	Dead	Living
Alvania reticulata	1	
Anomia ephippium	1	1
› *patelliformis*	8	1
Aporrhais pes pelicani	+	3
Astarte elliptica	$^1/_2$	3
› *montagui*	2	
› *sulcata*	$1^1/_2$	3
Axinus flexuosus	1	
Balanus porcatus	16	
Buccinium undatum	1	2
Cardium edule	$1^1/_2$	
Conulus millegranus	9	4
Corbula gibba	$^1/_2$	
Crania anomala	1	
Dentalium entale	8	18
Ditrypa arietina	2	
Echinocyamus pusillus	1	
Emarginula fissura	8	
Gibbula cineraria	9	
Lima loscombi	8	3
Littorina rudis	3	
Lucina borealis	6	
› *spinifera*	$^1/_2$	
Lunatia intermedia	1	1
Lyonsia norvegica	—	1
Modiolaria marmorata	$1^1/_2$	

	Individuals	
	Dead	Living
Mya truncata	$^{1}/_{2}$	
Mytilus edulis	$^{1}/_{2}$	
› *modiolus*	—	1
Nassa incrassata	4	
Nucula nucleus	6	
Pecten opercularis	—	2
› *tigrinus*	2	6
Saxicava arctica	2	
Terebratulina caput serpentis	4	1
Thracia villosiuscula	$^{1}/_{2}$	
Turritella terebra	10	4
Velutina laevigata	—	1
Venus gallina	$^{1}/_{2}$	
› *ovata*	19	3
Verruca stroemia	1	

In a single catch, consequently, the majority of the commonest forms in the bed were obtained in living condition; and there is every reason to suppose that the bulk of the shells in the bed are derived from the very spot or from the immediate vicinity.

Flatholmen I.

Table p. 665.

2 km SW of Lysekil, on the northeast side of Flatholmen, about 30 m depth, August, 1919.

The shell gravel contained plenty of clay and pebbles.

Of the 58 species identified in the catch 30 are d-forms, 22 sd-forms, and 5 s-forms. The shallow-water forms are with few individuals represented by *Cardium edule*, *Littorina littorea-rudis*, *L. obtusata*, *Mytilus edulis*, and *Onoba striata*. *Cardium* and *Mytilus*, though, sometimes go down on deep water. Thus, only little transportation of shells has occurred from the nearest neighbourhood.

In passing it may be mentioned that *Pecten islandicus* is represented by a young shell and thus is probably living on the spot.

Flatholmen II.

Table p. 665.

About at the same spot as Flatholmen I, about 30 m depth, August 8, 1919.

The shell gravel is very stony and somewhat sandy but only slightly clayey. The number of species found in the sample is 61. Of these 33 are d-forms, 22 sd-forms, and 6 s-forms. The shallow forms, represented by a few individuals, are *Hydrobia ulvae*, *Lacuna divaricata*, *Littorina littorea-rudis*, *Mytilus edulis*, *Onoba striata* and *Rissoa membranacea*. These species, and perhaps also a few others, may have been transported some distance, while the great bulk of the shells in the bed in all probability are derived from the spot or its immediate vicinity.

Gråskär.

2.5 km SSW of Lysekil, halfway between Blåbärsholmen and Gråskär, 25 to 30 m depth, August 14, 1919.

The haul consisted of fine-grained shelly clay, in which the following species were found:

	Ind.		Ind.
Cardium echinatum	$1^1/_2$	*Mytilus edulis*	$1^1/_2$
» *edule*	$^1/_2$	*Nucula sulcata*	2
Cypriana islandica	2	*Ostrea edulis*	$^1/_2$
Dentalium entale	2	*Turritella terebra*	2
Littorina littorea	2	*Venus gallina*	$1^1/_2$
Lucina spinifera	10		

Cardium echinatum, *Lucina*, and *Venus* were represented by living specimens as well as by empty shells.

Cardium edule, *Littorina*, and *Mytilus* are littoral forms that may have been transported at least a few hundred meters. *Ostrea* may also have been transported. The others may have lived on the spot or close by.

Gåsöredd.

Table p. 665.

3 km SW of Fiskebäckskil, between Skaftölandet and Gåsö, 30 to 40 m depth, August, 1919.

In the center of this sound, which is about 700 m wide, dredgings were made on five different occasions.

Gåsöredd I. — About 30 m depth. The shell gravel is very stony and somewhat sandy and clayey. The shells are large and complete; fragments are very subordinate, so that both species and individuals are few in sample. Of the 25 species 12 are d-forms and 13 sd-forms. *Gibbula cineraria*, *Ostrea*, *Tapes aureus*, and *Tectura*, which do not occur under conditions like those prevailing on the spot, may be derived from shallower water and have been carried out a few hundred meters.

Gåsöredd II. -- The dredging was made in the center of the sound from Stockviken to Lerbogen and on depths of 30 to 40 m. The shell gravel is very stony and clayey. The number of species found in the sample is 41. Of these 20 are d-forms, 18 sd-forms and 3 s-forms. The last-mentioned are represented by individual specimens of *Lacuna divaricata*, *Littorina littorea-rudis*, and *Onoba striata*. These together with some other forms as *Bittium*, *Cardium exiguum*, *Mya truncata*, *Nassa reticulata*, *Ostrea*, and *Tectura* may come from shallower water with other kinds of bottom. Most of the species, and particularly the numerously represented *Anomia*, *Balanus crenatus*, *B. porcatus*, *Turritella*, and *Venus ovata*, are primarily living on just such localities as this.

Gåsöredd III. — Near Löken about 30 m depth. The shell gravel is very stony and rather clayey. The number of the species is 44. Of these 22 are d-forms, 20 sd-forms, and 2 s-forms. Beside the s-forms *Littorina littorea-rudis* and *Macoma baltica*, at least *Bittium*, *Cardium exiguum*, *Gibbula cineraria*, *Odostomia albella*, *Ostrea*, *Rissoa interrupta*, and *Tectura* may have been washed down from shallower water.

Gåsöredd IV. — About 30 m depth. The shell gravel is very stony and somewhat clayey. The number of species is 40, of which 18 are d-forms, 19 sd-forms, and 3 s-forms. *Littorina littorea*, *Mytilus edulis*, and *Onoba striata* of the last-mentioned group may be derived from the shore or its vicinity, and so probably also *Bittium*, *Cardium exiguum*, *Gibbula cineraria*, *Nassa reticulata*, *Ostrea*, and *Tectura*. The forms enumerated are represented by single individuals only and are of subordinate importance in the deposit.

Gåsöredd V. — About 40 m depth. In the shell gravel, which is very stony and clayey, the following empty shells and living animals were found:

	Individuals	
	Dead	Living
Anomia aculeata	½	
» *ephippium*	10	
» *patelliformis*	3	
Aporrhais pes pelicani	2	3
Astarte montagui	½	
» *sulcata*	½	
Axinus flexuosus	1½	
Balanus porcatus	4	
Buccinum undatum	+	1
Cardium edule	½	
Clathurella linearis	1	
Conulus millegranus	1	
Corbula gibba	—	3
Cyprina islandica	1	
Dentalium entale	1	3
Ditrypa arietina	12	8
Dosinia lincta	1	
Leda minuta	½	
» *pernula*	½	1
Lima loscombi	½	
Littorina littorea	4	
Lucina borealis	5	
» *spinifera*	1	
Lunatia intermedia	2	
Nassa reticulata	4	
Nucula nucleus	10	6
Pecten opercularis	1	1
» *tigrinus*	1	2
» *varius*	1	
Saxicava arctica	2	
Turritella terebra	15	3
Venus ovata	14	7

Of the 31 molluscs and balanids 27 are d-forms, 8 sd-forms, and 2, *Cardium* and *Littorina*, littoral forms. These latter, together with *Nassa reticulata*, may have been transported from shallow water. The 11 species found alive show that the shell gravel is in great part forming of animals living on the spot.

Plymouth.

In the English Channel, off Plymouth, shell beds are frequent at depths of between 35 and 45 m. They deserve mention, as their faunas have been statistically studied (Ford, 1923, pp. 202—206).

Furuholmen.

1.5 km SW of Strömstad, S of Furuholmen, about 50 m depth, G. De Geer.

In fine clay from this locality occur:

	Ind.		Ind.
Aporrhais pes pelicani	1	*Pecten opercularis*	$1^1/_2$
Balanus porcatus	1	*Turritella terebra*	15
Lucinopsis undata	$1^1/_2$	*Venus gallina*	$^1/_2$

All are forms that extend out to considerable depth; and they may have lived on the spot.

Gullmaren.

Table p. 665.

Locality not more definitely indicated, 60 to 80 m depth.

The shell gravel was dredged by Dr. Axel Goës long ago. It has been analyzed by the writer. It consists to a large extent of pebbles, many of which are 1 cm in diameter. As it lacks fine material, it has probably been sifted by Goës.

Of the 46 species represented 22 are d-forms, 20 sd-forms, and 4, viz. *Littorina littorea-rudis*, *Mytilus edulis*, *Onoba striata*, and *Purpurea*, are s-forms. Besides these at least *Bittium*, *Cardium exiguum*, *Gibbula cineraria*, *Nassa reticulata*, *Rissoa*, *Tectura*, and *Triforis* probably are derived from the littoral belt or the laminarian belt. How far they have been transported cannot be stated. The great bulk of the shells, however, belong to forms that may have lived on the spot. It is of interest that shell gravel with subordinate littoral and shallow-water forms is being deposited at so great a depth.

Composition of the beds.

The compositions of the principal modern beds examined are given in the following tables. The figures indicate the number of species belonging to the respective groups, except when otherwise stated.

Geographical composition.

	Depth in m	ax	alx	bx	bmx	bmx	blx	blx	Total
Littoral beds.						%		%	
Smalsundet A		4	10	11	2	6	7	21	34
» B		3	8	5	1	5	4	20	21
» C		4	14	13	2	5	9	22	42
Kristineberg II A		5	9	13	2	6	5	15	34
» II B		9	12	12	5	11	8	17	46
» II C		8	13	10	5	12	4	10	40
» II D		4	13	12	3	8	4	11	36
» II E		4	12	13	3	8	4	11	36
Fiskebäckskil II		1	7	3	1	6	5	30	17
Hermanö III		7	16	10	3	8	4	10	40
Ålstenshamn II		3	13	4	3	11	4	15	27
Vik III		3	6	4	—	—	4	23	17
Vikekilen II		3	9	8	3	11	5	18	28
» III		4	7	6	1	5	4	18	22
Svenneby III A		4	13	7	2	6	7	21	33
» III B		6	13	10	2	5	6	16	37
Skarvik		7	10	6	5	16	3	10	31
Range of fluctuations		1—9	6—16	3—13	0—5	0—16	3—9	10—30	17—46
Means		5	11	9	2.5	7	5	17	32
Shallow-water bed.									
Strömsund	4—5	7	11	5	—	—	6	20	29
Deep-water beds.									
Bärviken	15	8	6	8	2	7	4	14	28
Lindholmen I	15	8	9	11	3	7	7	18	38
» II	15—20	8	8	10	5	13	8	21	39
Range of fluctuations	—	8	6—9	8—11	2—5	7—13	4—8	14—21	28—39
Means	—	8	8	10	3	9	6	18	34
Humlesäcken	25—30	13	17	20	9	13	9	13	68
Flatholmen I	30	10	16	15	8	14	8	14	57
» II	30	12	13	16	8	13	12	20	61
Gåsöredd I	30—40	5	4	8	4	16	4	16	25
» II	30—40	9	9	14	4	10	5	12	41
» III	30	9	10	13	6	14	6	14	44
» IV	30	8	11	11	5	12	5	13	40
» V	40	7	6	7	8	26	3	10	31
Range of fluctuations	—	5—13	4—17	7—20	4—9	10—26	3—12	10—20	25—68
Means	—	9	11	13	6.5	15	6.5	14	46
Gullmaren	60—80	7	13	16	4	9	6	13	46

Bathymetrical composition.

	Depth in m	s		sd		d		Total
Littoral beds.			%		%		%	
Smalsundet A, B		12	31	20	51	7	18	39
» C		15	36	24	57	3	7	42
Kristineberg II A—II E		16	24	30	45	21	31	67
Fiskebäckskil II		10	59	7	41	—	—	17
Hermanö III		13	42	20	50	7	18	40
Ålstenshamn II		10	37	15	56	2	7	27
Wik III		3	18	14	82	—	—	17
Vikekilen II		8	29	17	60	3	11	28
» III		5	23	14	63	3	14	22
Svenneby III A, III B		15	31	27	56	6	13	48
Skarvik		7	23	16	51	8	26	31
Range of fluctuations		3—16	18—59	7—30	41—82	0—21	0—26	17—67
Means		10	32	19	55	5.5	13	34
Shallow-water bed.								
Strömsund	4—5	7	24	16	55	6	21	29
Deep-water beds.								
Bärviken	15	3	11	13	46	12	43	28
Lindholmen I	15	2	5	21	55	15	40	38
» II	15—20	2	5	21	54	16	41	39
Range of fluctuations	—	2—3	5—11	13—27	46—55	12—16	40—43	28—39
Means	—	3	7	18	52	14	42	32
Humlesäcken	25—30	6	9	25	37	37	54	68
Flatholmen I	30	5	9	22	38	30	53	57
» II	30	6	10	22	36	33	54	61
Gåsöredd I	30—40	—	—	12	48	13	52	25
» II	30—40	3	7	18	44	20	49	41
» III	30	2	5	20	45	22	50	44
» IV	30	3	8	19	47	18	45	40
» V	40	2	6	8	26	21	68	31
Range of fluctuations	—	0—6	0—10	8—25	26—48	13—37	45—68	25—68
Means	—	3.4	7	18	40	24	53	46

The geographical composition of the beds thus varies considerably. The b¹x forms fluctuate between 10 and 30 per cent. Their numbers and still more the rôle they play are in some cases insignificant. There is on the whole no marked difference between the littoral beds and the deep-water beds, but the clay from 50 m depth at Furuholmen (p. 517) contains a fauna whose warmest species extend up to Lofoten. From these conditions it follows that the geographical composition is a limited means for the dating of raised shell beds (cf. p. 539).

The bathymetrical composition of the littoral beds is distinctly different from that of the beds formed in 30 to 40 m of depth. If the frequency of the species is taken into account, and not merely their number as in the table, the difference is still greater. In the littoral beds the d-forms are normally present in subordinate numbers, single shells, or fragments. In the deep-water beds the s-forms are present in corresponding numbers. Between the littoral beds and those deposited in depths of 15 to 20 m there is an evident distinction. This is important as showing that the depth on which raised shell beds were formed can in most cases be approximately determined.

Formation of shell beds.

Mode of occurrence. Types.

The first condition of accumulation of large shell beds is a rich mollusc life. This in its turn demands an abundant supply of food and lively water circulation. Settling of the easily movable shells requires quiet water. Large shell beds are therefore deposited in quiet places in the immediate proximity of open or circulating water. Not only large beds but the great mass of shell deposits are formed under such conditions. Shell beds are formed on and near the shore in quiet coves; at the shore and in moderate depth on the inside of islands; in the deep parts of bays and basins; in sounds; in short passages between islets; below steep cliffs, etc. Small and poor shelly deposits are sometimes formed in quiet bays with diluted, stagnant water.

Raised shell beds occur in corresponding situations. They are frequently to be found in small reëntrants and side valleys, which during the formation constituted coves of bays or sounds, were protected from the direct attack of the waves, and yet had good water circulation. The beds Fjällbacka, Udden, Valö, and Ellene are good examples of this type and are comparable to Kristineberg II, Hermanö III, Skarvik, and Vikekilen III, which are under formation. Raised beds also often occur in the center of valleys, especially near or at the end, and on the lee side of rocks and hills. Finally, they are frequently found in short narrow passages or notches at the pass point and just inside or entirely on the inside. Beds in the last-mentioned situations sometimes have great extent and thickness. Good examples are Otterö and Svälte (ANTEVS, 1917), which agree well with Smalsundet now forming.

Numerous, large, and thick shell beds are limited to coasts with sounds, bays, fjords, and a belt of islands, a skerry guard. On the Swedish west coast real shell beds begin on the transition from the plain to the broken landscape somewhat south of Göteborg.

The shell beds formed on the shore line, between the tidal marks and above, are mostly thin and underlain by sand. They consist predominantly of shells washed up from the shallow water in the vicinity.

The beds deposited in water from a few meters to 15 or 20 meters of depth on the lee side of islands, on the inside of notches, in sounds, etc. sometimes reach a diameter of a few hundred meters and a thickness of more than 5 m. They frequently consist to a large extent of light and minute shells, indicating very quiet water on the spot of accumulation. The animals lived on the very spot and in the immediate vicinity. The beds are mostly remarkably free from mineral matter, sometimes containing practically no pebbles, sand, or clay.

The beds formed at depths of 25 to 40 m in the skerry guard of Bohuslän are clayey, sometimes so clayey as to be rather shelly clay. The shells are essentially of animals that live on the spot. Solitary shells are derived from the shore belt, having been washed out by waves, or having been transported by seaweeds, or in some other way. Shell beds of this kind, formed of shells in situ, may grow slowly. Raised beds that are undoubtedly of this type are not known to the writer.

It is not known to the present writer what kinds of beds are now forming in relatively deep water below cliffs, but during the latter part of the last upheaval primarily oyster beds were deposited in such places. The oyster beds consist quite predominantly of shells of *Ostrea* with shells of *Rissoa* and other small species forming a small part. They usually contain some clay. The heavy oyster shells may have sunk to the bottom upon detaching from the rock walls. The small and light shells may — perhaps chiefly as the bed passed the shore line during its rise — have been trapped in the spaces between the oyster shells, just as silt is held between boulders on a shore, where not even pebbles can remain.

Source of material. Transportation.

The shells in a bed are derived from animals that lived on the bed and in its vicinity. The percentage of transported shells varies greatly in different kinds of beds and is not easily estimated. The fact that a form generally lives in another association and other conditions than the majority of the species with which it is deposited affords no certainty that it did not live among them but was transported from elsewhere or redeposited. Knowledge of the conditions of occurrence of the molluscs is very unsatisfactory.

Our observations show that in some beds, especially beds formed at fairly great depth out in the bays, transported shells play a very subordinate rôle, while in others, especially littoral beds, they may play a dominant rôle. Distance of transportation may usually be measured in tens of meters, but sometimes in hundreds of meters. It is seldom very long in Bohuslän, as, on account of the exceedingly broken coast, the shells normally soon find a quiet place in which to remain. Thus, the bulk of the shells in the beds are derived from animals that lived on the very beds and in their immediate proximity.

The means of transportation of the shells are waves and currents. The transportation is frequently facilitated by plants and sometimes by ice and by filling with gas and air.

In exposed places there is a belt in which the waves strike the bottom with sufficient force to remove empty mollusc shells. From here waves transport shells landward, if the slope of the bottom is gentle; and seaward, if the slope is steep. Where the water is so shallow in comparison with the wave length that a steepening of the wave front is produced the waves may drive pebbles and cobblestones toward the beach and carry sand and silt toward deep water at one and the same time (Johnson, 1919, p. 91; Wheeler, 1902, p. 22). However, whether small and light shells are thus carried seaward is not known to the present writer.

Halden's and Sandegren's view that shell beds are almost exclusively formed of downwashed shells (see p. 497), may be an unwarranted generalization from one mode of formation. The bed Kristineberg II, for instance, is forming at the foot of a precipitous rock largely from upwashed shells (p. 501). Beds in such situations as described by Sandegren (1924, pp. 158—167) may equally well be deposited in shallow water and at the shore. At least the Hinsholmen bed, occurring at the foot of a steep elevation, may be a shallow water deposit as being predominantly composed of shells of species common near the shore. The broken topography of rocks and hills is primarily important for the formation of shell beds by producing favorable living conditions in general for the animals and quiet spots on which the shells can settle.

The greatest depth from which shells are washed ashore varies with the exposure, the strength of the waves, the slope of the bottom, the weight and shape of the shells, etc. In the open Kattegatt it is about 12 m and in the open North Sea some 15 to 20 m (JOHANSEN, 1901, pp. 21, 24). In Bohuslän, where the waves are checked by skerries and islands, the greatest depth is generally less than 10 m. Shells of bivalves seem to be more easily washed up than shells of gastropods, because they have a larger surface of attack in relation to weight than do the latter. Shells thrown up from relatively great depths on a strongly exposed point can be transported by waves along the shore and come to rest at a place outside which the waves have but little power.

The shells carried shoreward are assorted according to weight and size and according to the strength of the waves and deposited from below the water surface to above the high-water mark, at a place from where they cannot be removed by the waves. Thick heavy shells and heavy fragments come to rest farthest out, and light shells with large surfaces are thrown farthest up. It is largely empty shells that are washed ashore. The resulting beds apparently consists largely of shells transported a shorter or longer distance.

On the inside of islands and islets the waves often come from two sides and die as they meet. They frequently bring along shells which become deposited in the quiet water at depths of from a few to several meters and which, together with animals living on the spot, form large and thick shell beds.

In sounds, especially, currents are the chief transporting agency. At such places the tidal currents frequently are very strong; and, as the animal life, on account of the lively water circulation, is very abundant, the transported quantity of shells may perhaps be large. However, transportation is seldom far, only to the nearest quiet place.

Plant fragments torn loose by the waves and washed ashore or carried seaward are an important means of facilitating transportation of molluscs, as may be inferred from the frequent ridges of fucus and zostera on the shore and from the fact that these plants serve as home and foundation for a great many molluscs. (Also Baker, 1895; Vallentin, 1895.)

Transportation of shells of gastropods is sometimes made possible by the formation of gases, as the dead animals decay, or by filling with air, etc. Gas formation is especially important in causing shells in deep water to rise to the upper water strata, where they are transported by the waves. Most of the empty shells of *Rissoa* and other small forms are extremely light and, if filled with air, plant remains, etc., no doubt can be carried long distances. Occasionally transport is made possible by ice.

Accumulation of shells thus takes place in quiet spots near water that is frequently renewed. The shells are derived from animals that lived on the spot or in the vicinity. Shells brought by waves and currents are distributed over the bed. Where they have been deposited after a storm they remain, unless removed by exceptionally severe storms or by marked changes brought about by the rise or fall of the shore line.

Redeposition.

If the relation of land and sea remains unchanged, shell beds will continue to grow outward and upward until they reach too movable water or the surface of the water. Little or no redeposition of the shells after they have once really come to rest will take place under these conditions. However, the shore line in Bohuslän has in late-Quaternary time been shifting up and down almost constantly and so complicating the history of the shell beds.

When the shore line remains stationary or is receding slowly, littoral shell beds normally do not attain a thickness of more than a few decimeters; but upwashed shell gravel may, of course, be deposited on top of a thick shell bed formed in water of some depth and raised to the surface. When uplifted, the littoral beds evidently escape the reach even of storm waves, but they may be redeposited by running water. Under favorable conditions they continue to grow in their outer parts.

Accumulation of shell material beneath the water surface and retreat of the shore will cooperate to diminish the depth of the overlying water. Littoral molluscs will play an increasing rôle. Normally the situation becomes more and more protected and quiet, so that no redeposition takes place. The bed forming in the Smalsundet (p. 499), for instance, will be built on for the whole width of the strait until it will rise slightly above the storm line, and then it will grow at both ends. There will clearly be no redeposition worth mentioning except eventually on the outer side during storms of exceptional violence. Similarly, beds forming in more or less shallow water on the inside of islets and rocks will normally cease to grow in quiter water. Sometimes such shell beds, as they approach the water level, may possibly come into an exposed situation and become subject to abrasion and redeposition; but the present writer knows of no instance of this.

Beds forming in sounds may during regression become more protected or more exposed mainly in accordance with decrease or increase of the strength of the currents, which may wash away light shells. Beds formed as talus at the foot of bluffs may frequently become exposed and more or less redeposited, and new shells may be mixed in. Thus, part of the *Rissoa* and *Bittium* shells that occur in oyster beds may often have been added during the raising of the beds. Also shelly clays and beds formed in wide bays below the influence of the strongest waves may frequently be redeposited, perhaps repeatedly, as they are raised towards the water level.

During regression of the shore line, or rise of the land, consequently, redeposition worth mentioning can take place only in beds deposited below the zone of displacement and coming into an exposed situation.

During transgression, or upward shift of the shore line, the results are essentially different. Littoral beds are gradually washed higher and higher as long as the shore is sloping gently. New shells are mixed with the old ones. The originally thin beds attain a considerable thickness. The outer parts may frequently be buried beneath sand and thus be preserved. Where the topographic conditions so permit the displacement proceeds until the limit of the transgression is reached. If the water reaches steep rock walls the shells are transported along the shore, if the topography is favorable, but otherwise they may be ground to pieces against the rocks and pulled seaward by the undertow.

Shell beds deposited below sea level, in quiet places near the surface or below the zone of displacement, may not undergo any redeposition during transgression, provided strong currents do not begin to sweep over the place. But the bed can grow at the same rate as the submergence proceeds, and the fauna may remain unchanged; or it can grow faster or slower, and molluscs preferring shallower or deeper water may immigrate to the spot. Shell beds formed under these conditions can apparently attain considerable thickness; but not all particularly thick beds are thus formed, as held by Mrs. CLEVE-EULER (1926); some may have been deposited during a continuous regression, as, for instance, Stensbo, Udden I, Fjällbacka III.

Thus, theoretically, redeposition may play a subordinate rôle except in littoral beds during transgression and deep-deposits during regression. Observations by the writer seem to bear this out. They tend to show that the presence of shells belonging to other associations or communities than the majority only exceptionally means redeposition but transportation before settling. Some idea of the extent of the redeposition may be gained from the occurrence of distinctly late-glacial shells in post-glacial beds. The large-sized Balanidae and Saxicavae, which almost alone form the late-glacial beds and which are rather characteristic, are found only in a small percentage of the post-glacial shell deposits. Thus, late-glacial shells in numbers worth mentioning occur only in Nötholmen and Hälle III among the numerous post-glacial beds described by this writer in 1917. Besides in the two beds mentioned *Portlandia arctica* was found only in Otterö B and in Svälte. Other essentially arctic forms as *Astarte*, *Leda*, and *Pecten islandicus* still live, mostly as relicts, on the coast of Bohuslän and are in places even common, so that their presence in post-glacial beds need not be due to redeposition. But even these are quite rare in the post-glacial beds. *Astarte elliptica* occurs only in Lunnevik II. *Leda minuta* is found in Nötholmen, Hälle III, and Gullmaren. *Pecten islandicus* is met with in Fjällbacka, Löndal, Mörhult, and Tofterna. *Portlandia lenticula* occurs in Tofterna, Nötholmen A, and perhaps Nordkoster.

As the larger shell beds are used for different purposes the writer has had the opportunity of observing several sections of considerable depth and as much as 100 m long. All have been characterized by a distinct, mostly somewhat sloping stratification. Throughout the sections a nearly parallel bedding has been observed, showing that after the levelling of the larger irregularities in the substratum all parts have grown at about an equal rate and one part has not increased by material eroded from another part. New shells have been equally distributed by the waves. Washing down of shells from the upper part of a bed and deposition on its outer part does not normally take place in a gently sloping bed in the shallow-water belt, for all or nearly all transportation is onshore. Exceptions may occur when the bed rests against a steep rock, when the waves come from two directions, or when the wave length is great in comparison with the water depth (cf. p. 522).

In small beds, in which the bedding is usually more sloping, the structure is a less reliable indicator, for the whole bed may have been redeposited, so that no indication of the process exists.

Rate of growth.

The rate of accumulation of shell gravel is dependent on a number of conditions and thus varies greatly. It depends on the wealth of the animal life on the spot, on the rôle of transportation of shells from the vicinity, on the rate of growth of the animals, etc. The abundance of animals varies extremely: it may be surprisingly great at places affording rich nourishment and favorable bottom, salinity, and content of carbon dioxide (PETERSEN, 1914; ODHNER, 1915; ANTEVS, 1918; FORD, 1923). Transportation of empty shells to quiet spots can no doubt be great, though no direct studies on the subject have been made.

The rate of growth of molluscs has lately been made the subject of som study at Plymouth on the English Channel. *Patella vulgata* was found to attain a size of 4 cm in less than 15 months and to be ripe at this age (ORTON, 1913, p. 319). A specimen 2 years old measured 5.3 cm.

Abra alba developed one growth ring each year, in the late winter or early spring (FORD, 1925, p. 540). It grew slowly; the shells measured 9, 11, and 12 mm at the end of the first, the second, and the third year, respectively.

Anomia aculeata became full-grown and ripe at an age of less than 4 months (ORTON, 1913, p. 320). It passed through two and probably three generations within a year.

Cardium echinatum reached an average length of 18 mm during the first year (FORD, 1925, p. 547).

Cardium edule, as measured on the winter rings, attained lengths of 19 to 22 mm in the first year, 28 to 32 mm in the second, 33 to 36 mm in the third, and 35 to 39 mm in the fourth year (ORTON, 1926, p. 277).

Cultellus pellucidus, spatted in June, grew to 15 to 20 mm by the autumn of the same year (FORD, 1925, p. 556). In the Limfjorden, Denmark, the species attained 15 to 20 mm in the first year and 25 mm in the second year (JENSEN, 1919).

Mytilus edulis attained a length of 3.5 to 4 cm in the first summer (ORTON, 1913, p. 318). During the winter it did not grow appreciably. At the end of the second summer, or the age of 18 months, it averaged 5 cm in length. . It spawned normally at the age of one year.

Ostrea edulis attained an average size of 75 sq. mm in 10 weeks (ORTON, 1913, p. 323). The market oyster is several years old.

Mya arenaria, on the south coast of New England, grew from a length of 11 mm to that of 20 mm in the time from July 10 to August 16 (KELLOGG, 1905, pp. 210, 223). Clams from 2.5 to 6.7 cm long increased in volume in one year from 28 per cent to 1 150 per cent.

Mya truncata in the Ice Fjord, Spitsbergen, shows distinct annual growth rings (ODHNER, 1915, p. 123). Shells 3.5 to 4 years old were 10 to 11 mm long, specimens 5.5 to 6 years old were 15 to 20 mm, and shells 12 to 13 years 38 to 41 mm long.

Experiments in the Ice Fjord, Spitsbergen, tend to show that calcareous marine animals there, in water whose temperature does not rise above 4° C., grow at about the same rate as they do in England (ORTON, 1923).

A combination of a rich molluscan fauna, an effective transportation of shells from the vicinity, and a rapid growth of the animals will give rise to quick accumulation of shell gravel. The bed in the Smalsundet (p. 000) has grown from a few to several meters in the last 100 years, for while the sound now is hardly 1 m deep, 100 years ago it permitted large vessels to pass through, according to information given the late Professor HJALMAR THÉEL by an old fisherman.

The late-glacial bed Kapellbacken at Uddevalla, probably the largest raised bed on record, is 600 to 700 m long, some 300 m broad, and at places 5 m thick (DE GEER, 1910, p. 1152; pl. 43). Otterö, a post-glacial bed, is at least several hundred meters long, 100 m broad, and more than 6 m thick (ANTEVS, 1917, p. 271). In the case of some horizons more than 95 per cent by weight consists of shell material, and as the shells are very small their number is enormous. Several other beds studied are hundreds of meters long or across, but most beds are a few tens of meters or less in diameter.

The thickest beds on record are the late-glacial Kuröd and the post-glacial Lunnevik, which are 12 to 15 and 8 m thick, respectively (DE GEER, 1910, pp. 1150, 1168, 1179; BRÖGGER, 1901, p. 313; ODHNER, 1927, p. 78). Several beds are known to exceed 5 m in thickness.

Relatively insignificant immigration of new molluscs during the time of formation of many large beds might indicate that this was short.

The clay layers.

Below, in, or above some shell beds is a layer of clay.

On a coast exposed to the waves easily suspensible clay particles sink to the bottom, to remain there at depths varying from a few tens to several tens of meters. On a broken coast, as in Bohuslän, where the waves are checked by skerries and islands, they settle in comparatively protected places in depths of about 10 m. In the Gullmarsfjorden, clay is to be found from about 20 m downward, according to dredgings carried out by Kristineberg Zoölogical Station (THÉEL, 1907, pp. 102—125). In small quiet bays into which streams discharge mud may settle at any depth, however little. However, no great amount of clay is deposited on the coast of Bohuslän, for sediments reach the sea only as narrow strips in the innumerable glens and small valleys between the naked rock plateaus, the predominating clastic sediment is sand, and the watercourses are insignificant. The actual conditions under which the clays associated with shell gravel were deposited can in several cases be determined from the changes in the composition of the faunas, etc. For instance, a high percentage of shells of deep-forms just below, in, or above the clay bed suggests that this was formed in deep water. Increase of the deep-forms and decrease of the shallow-forms upward in a bed to the clay layer, and decrease of the former and increase of the latter from the clay upward indicate that the clay was deposited in deeper water than any part of the shell gravel. On the other hand, increase of the shallow-forms in a thick shell bed upward to the clay would suggest that this was laid down in very shallow water. As the formation of rich shell gravel demands abundant mollusc life and this in its turn free water circulation, and as the settling of the clay in insignificant depth requires closed and still water, a decided change in the conditions caused by alterations of level or so must take place in this case. Where conditions are favorable for the deposition of shell gravel on shallow water there fine mud cannot settle, and where mud can go down to stay in slight depth, as in small landlocked bays, there the animal life is altogether too poor for the accumulation of large shell deposits. The shell gravel nearest the clay and the fauna of the clay should show the effect of the lessened nourishment, salinity, and percentage of oxygen by the disappearance of many forms and the appearance upon the scene of brackish water species. Such a decided change seldom occurs, as an examination of a few cases will show.

Tofterna. — (De Geer, 1910, p. 1182, Pl. 45; Antevs, 1917, pp. 299, 308; Odhner, 1918, p. 216). The profile is as follows:

Topmost, 1 m sand.
6.5 m shell gravel, very clayey toward the bottom.
6.3 m post-glacial clay, somewhat gravelly at the bottom.
Bed rock.

The shell deposit occurs in a glen, 50 to 75 m wide, between steep rock walls some 20 m high. It extends up to the level of 14 m; the surface at the chief section lies at 8 m.

The fauna of the clay consists of 3 s-forms, 10 sd-forms, and 15 d-forms. The faunas of the shell bed at 2, 4, and 7 m of altitude have the compositions, respectively: 6 s-forms, 19 sd-forms, and 32 d-forms; 7 s-forms, 19 sd-forms, and 13 d-forms; and 8 s-forms, 21 sd-forms, and 10 d-forms. The faunas of the clay as well as of the lower part of the shell bed are comparable to those dredged from depths of some 30 m in the bays and sounds. The whole bed was probably formed during a continuous rise of the land, though the variations in frequency of many forms is peculiar. If this is the case, here is an additional evidence that the clay was laid down in deep water.

Torseröd. — (Antevs, 1917, pp. 281, 307; Odhner, 1918, p. 213). The sequence of strata is:

Topmost, 4 m shell gravel.
Clay, at the top free from shells, but becoming shelly downward.
>1.5 m shell gravel. Sample of clayey shell gravel 0.8 m below the top of the clay.

The surface of the shell gravel lies about 6 m above sea level. The bed occurs near the mouth of a narrow valley at the foot of a rock wall that with a few steps rises steeply about 25 m. It is large and forms a broad bar which reaches about 4 m above the level valley bottom. It lies where, when the region was submerged, the currents of the small valley in which the shell bed occurs and of the adjoining north-southerly main valley must have met and neutralized each other. Its situation and shape are determined by the currents. Consequently, and as is shown by the mixture of mud-forms with such as prefer a substratum of shell gravel and rocks, a large percentage of the shells have been transported to the spot. The numerous *Littorina* and *Balanus*, beside others, no doubt lived on the rock walls. The bed is clearly in part a talus formation. But, as it forms a bar with a level crest rising above the valley bottom, its upper and larger part cannot possibly have been formed by redeposition of the older parts of the bed. In fact, there is nothing indicating a redeposition worth mention.

The upper part of the shell gravel underlying the clay is composed of 8 s-forms, 22 sd-forms, and 9 d-forms and may have been deposited in shallower water than the gravel just above the clay, which is composed of 9 s-forms, 25 sd-forms, and 12 d-forms. The superjacent shell deposit, 4 m thick, was probably formed in water whose depth was decreasing, as *Littorina* and *Lacuna* grow in numbers upward and the rôle of d-forms diminishes, the composition at the top being 8 s-forms, 26 sd-forms, and 8 d-forms.

Thus, and because the conditions of settling of the clay particles in the current-swept sound were then most favorable, the clay probably is derived from a time of deeper water than the shell gravel. It cannot at any rate have been formed during the last rise shortly before the shore line passed its level, for the overlying thick shell gravel is not redeposited and the rich fauna and the shape of the bed show that currents constantly swept through the sound.

All things considered, it is most likely that the clay was deposited during the climax of the post-glacial subsidence, when the height of the water over the place was 35 to 40 m.

Otterö. — (ANTEVS. 1917, pp. 271, 315; ODHNER, 1918, p. 210; HALDEN, 1925). The deposit shows the following strata:

Topmost, 0.3 m mold.
0—> 0.5 m coarse shelly gravel with numerous cobbles.
0—> 0.3 m clay.
Probably more than 10 m shell gravel. Bottom not reached.

The deposit is enormous and fills at least the whole southeastern part of the glen, 100 m wide, which traverses Otterö island. The walls of the glen rise steeply to a level plateau at a height of 18 m above the sea. The surface of the bed sinks gently towards the mainland, and so do the strata, as observed in a trench between the pits, so that series B, though at a lower actual level than series A, stratigraphically begins about 3 m above the top of the latter. The height of the surface of the bed at A is 8 m and at B 6 m. The shell bed occurs in exactly similar situation as does the modern bed Smalsundet (p. 499).

In the lower bed, profile A, the composition of the fauna of the samples at 2, 4, and 7 m altitude is, respectively: 8 s-forms, 17 sd-forms, and 6 d-forms; 6 s-forms, 21 sd-forms, and 5 d-forms; and 7 s-forms, 22 sd-forms, and 4 d-forms. All these strata, about

5 m thick, may have been laid down in shallow water, in water a few meters deep. The number of s-forms and d-forms does not change appreciably, but the frequency of many species undergoes marked changes. Especially significant is the fact that the typical s-forms *Mytilus edulis*, *Littorina*, *Lacuna*, and *Onoba* attain maxima in the middle horizon of the bed. This may mean that the water was shallowest when this part was formed.

In the superjacent part of the bed, exposed at B, the composition of the fauna of the samples at 3.8 and 5.2 m is 7 s-forms, 21 sd-forms, and 9 d-forms; and 7 s-forms, 20 sd-forms, and 11 d-forms, respectively. The d-forms, accordingly, are more numerous here than at A. Among the typical s-forms *Mytilus* decreases in frequency, whereas *Littorina* and *Lacuna* have small maxima at the top. At least in part these variations in frequency may be due to a great percentage of pebbles in the lowest sample of series B, at 3.8 m, and to the pulverized condition of the sample at 4.5 m. The conditions as a whole may indicate increasing water depth.

The clay bed rests conformably upon the shell gravel. It wedges out, having probably undergone erosion before the deposition of the superjacent coarse shelly gravel, which also wedges out. The shell gravel inside the clay, actually higher but stratigraphically lower than this, was perhaps also abraded. The most characteristic constituent of the cobbly gravel is *Littorina*. The composition of the fauna is 5 s-forms, 14 sd-forms, and 6 d-forms. The bed apparently was deposited on the shore line, when this passed for the last time. Since, as the cobbly gravel indicates, the waves were strong on the shore line when the highest part of the shell bed began to rise above sea level, the clay whose settling required quiet water cannot very well have been deposited just before the cobbly layer in a depth at most of two meters. It must have been laid down in relatively deep water. Beside the composition of the fauna of the lower shell bed, its vertical thickness of more than 6 m combined with the probable fact that the lowest accessible parts of the bed were deposited in very shallow water suggests formation during transgression. For if the formation of the whole deposit had taken place during the last rise, when both regression of sea level and accumulation of material tended to shallow the water, the lower strata necessarily would have been laid down in water more than 10 m deep. Thus, as held by the present writer in 1917, the lowest exposed part of the bed may have been formed during regression, the upper part and the clay during transgression, and the topmost cobbly gravel during the last regression.

Nötholmen. — (De Geer, 1910, p. 1179, Pl. 44; Antevs, 1917, pp. 299, 310; Odhner, 1918, p. 217). The section presents:

Topmost, 1.2 m coarse gravel with boulders up to more than 1 m in size.
4 m shell gravel.
2 m post-glacial clay.
Bed rock.

The bed extends from sea level up to a height of 14 m. It lies at the foot of a steep rock plateau which rises to a height of more than 20 m. The clay contains a post-glacial fauna of the composition 4 s-forms, 11 sd-forms, and 2 d-forms. The shell gravel, judging from the upward increase of *Mytilus, Littorina,* etc., was deposited during regression, during the last uplift. The situation shows that the bulk of the shell bed cannot have been redeposited from an unknown bed beneath the clay. Deposition of overlying strata, more than 5 m thick, during rise of the land makes it evident that the clay was laid down in water that was many meters deep. The capping shore gravel clearly was formed as the shore line passed for the last time.

Udden II. — (See pp. 616, 619). The profile is:

Topmost, 0.05 m oyster gravel.
0.4 m shell-free clay with sharp contacts.
3 m shell gravel.
Clay with *Mytilus edulis.*

The surface of the bed lies at about 27 m altitude. In the lower bed *Mytilus* and *Littorina* reach insignificant maxima of frequency in the lower and middle horizons, respectively. The composition of the fauna is 5 s-forms, 9 sd-forms, and 3 d-forms in the bottom sample; 6 s-forms, 14 sd-forms, and 4 d-forms in the middle; and 6 s-forms, 19 sd-forms, and 7 d-forms in the top sample of the same bed. The surface of the bed lies probably 10 to 12 m below the limit of the post-glacial transgression. All things considered, the whole lower bed may have been laid down in water at most a few meters deep. At least the upper part of this lower bed may have been deposited during transgression though the evidence is not strong. If this be so, the clay may have been formed in a water depth of some 10 m during the climax of the post-glacial submergence, and the oyster bed, whose composition is 9 s-forms, 18 sd-forms, and 9 d-forms, during the last rise.

Fjällbacka. — (Antevs, 1917, p. 276; Odhner, 1918, p. 212). The shell bed, whose bottom has not been reached, is more than 4 m thick and is overlain by a clay layer 0.4 m thick. The top lies at a level of about 20 m. *Mytilus*, *Littorina*, *Onoba*, *Rissoa interrupta*, and others reach their maxima in the middle parts of the bed. Among numerously represented forms only *Bittium* and *Rissoa parva* attain maxima in the upper layers. The upward decrease of the most important shallow forms, *Mytilus*, *Littorina*, and *Lacuna*, may not be due to increased muddiness of the water as held by ODHNER, for mud occurs throughout the bed and in greatest quantity in the lowest sample, and all the forms endure well muddy water as the present writer has observed. Therefore the middle horizon of the bed may have been laid down in the shallowest water, and the upper part of the shell gravel and the clay during submergence. However, when the lower part of the clay was deposited, the depth was not yet great; for the composition of its fauna is 5 s-forms, 16 sd-forms, and 3 d-forms.

Fintorp I. — (See p. 627). Here a shelly post-glacial clay is overlain by a shell bed 0.75 m thick. The fauna of the clay lacks brackish-water forms and has the composition 4 s-forms, 21 sd-forms, and 8 d-forms. These conditions, the topography, and the fauna of the superimposed bed, whose composition is 6 s-forms, 25 sd-forms, and 13 d-forms, make it probable that the clay was deposited in relatively open water and at a depth of several meters.

Rössö-Lângö. — (DE GEER, 1910, p. 1184; ANTEVS, 1917, pp. 279, 313; ODHNER, 1918, pp. 209, 212). The profile shows:

Topmost, 0.5—1 m stony shell gravel.
0.2 m clay.
$>$2.8 m post-glacial shell gravel.

In the lower bed the real s-forms are too poorly represented to give any indication as regards the changes of level during the time of the formation of the bed. The practical absence of *Mytilus* is not necessarily due to the mud that occurs in the shell gravel. In profile A the composition of the fauna is 3 s-forms, 19 sd-forms, and 13 d-forms in the lower sample; and 2 s-forms, 20 sd-forms, and 15 d-forms in the sample just below the clay. In profile C the composition is 2 s-forms, 18 sd-forms, and 13 d-forms in the lower sample; and 3 s-forms, 18 sd-forms, and 12 d-forms in the upper sample. Thus, the whole lower bed may have been laid down in water that was more than 10 m deep. In the shell bed superimposed upon the clay the shallow forms are more numerously represented but they show different variations of frequency. *Littorina* and *Onoba* decrease upward, whereas *Mytilus* and *Lacuna* increase. The composition of the lower sample in profile B is 6 s-forms, 18 sd-forms, and 5 d-forms; and in the upper one 6 s-forms, 18 sd-forms, and 3 d-forms. The fauna suggests that the bed was formed in shallow water or possibly at the shore. The clay then was deposited in water that was at least several meters deep, but whether in deeper or shallower water than the lower bed cannot be stated.

N. Holt. — (Antevs, 1917, p. 283; Odhner, 1918. p. 214). The bed which occurs at an altitude of about 32 m, is more than 0.5 m in thickness and is covered by a clay 0.3 m thick. Besides the forms found in the statistical sample, the following have been identified in a sample: *Aporrhais pes pelicani*, *Dentalium entale*, *Leda pernula*, *Lepeta coeca*, and *Mactra subtruncata*. *Leda pernula*, at least, is redeposited from a late-glacial bed. The composition of the fauna is 11 s-forms, 22 sd-forms, and 13 d-forms. The bulk of the shells are of animals that prefer or are frequent in shallow water. Great numbers of *Mytilus*, *Littorina*, *Lacuna*, and *Onoba* are particularly suggestive. The d-forms are represented by few specimens. The composition of the fauna is thus comparable with that of modern shallow-water or littoral beds. If the deposit was formed in water that was a few meters deep the clay may have been laid down in somewhat shallower or somewhat deeper water. If the bed is a littoral deposit the clay was deposited, when the land stood lower, during a subsequent submergence. As the bed occurs at a level of 32 m and the post-glacial limit in the region at about 42 m, the water depth could not have been great.

Summary.

The clays in the treated cases may thus have been deposited in the following depths and under the following conditions:

	Depth in m	
Tofterna	about 30	
Torseröd	35—40	during the climax of post-glacial transgresssion
Otterö	30—35	» » » » » »
Nötholmen . . .	many	
Udden II	10	» » » » » »
Fjällbacka . . .	some to several	during submergence
Fintorp I	several	
Rössö-Långö . . .	»	
N. Holt	at most 10	

Thus the clay layers associated with shell beds are mostly deep-water formations, as was to be expected from the normal distribution of coarse and fine clastic sediments from the seashore outward.

III. Method of Study.

The method of investigation here used was worked out by De Geer (1910, pp. 1153, 1187). The aim is to get not merely lists of fossils, but objective data on the composition of the fauna in each layer and on the changes of the fauna and of the material from horizon to horizon throughout the bed.

In the field the mode of occurrence of the shell bed and the topography of the bed and of the surroundings are studied in order to determine the mode of formation and the origin of the shells. Detailed mapping is an object to be desired. It has been carried out by De Geer in the case of especially important beds. The stratigraphy of the deposit and the consistency of the material are carefully studied. Samples are taken in a fresh cut, so that each sample contains shells only from a certain layer, about 1 dm thick, and not such as is slumped down from higher levels. Samples are taken at different levels, if possible from the very bottom of the bed, and up to the top. The distance between the samples is varied according to the rate of change in the shell gravel, etc. As a rule 0.5 m or 1 m are good intervals. The samples are best kept in perfectly tight and strong paper bags.

In the office a certain quantity of the shell gravel is measured up to be analyzed. Care is taken that the part is characteristic of the whole sample. If the shells are large, 0.5 cubic dm or liter may be a good quantity; if they are small, 0.2 liter is sufficient. The selected shell gravel is weighed and then sorted after size. This is best done by washing and sifting in a large washbasin. The shell gravel is first washed over a sieve with holes 2 mm in diameter, and the material that goes through is again washed over a sieve whose holes are 1 mm in diameter. The different sorts are dried and then weighed and analyzed separately. So far the material that went through the 1 mm sieve has been kept but has not yet been studied. Of the largest sort all is taken, if the shells are not too numerous, otherwise only a part, a part accurately determined by weighing. Of the sort 1—2 mm a part is taken. The parts chosen are gone through in detail. The material is advantageously placed on a sheet of smooth black paper. The separation of the shells is made by small nippers with a soft spring, so that the brittle shells may not be crushed. As the process is very tedious, it is a good plan to pick out only such shells as are to be counted and, only as far as such shells are lacking, fragments and other shells. Of the gastropods the summits are counted, of the bivalves and the brachyopods the umboes, whose number is divided by two. Of the balanids the carinas are counted, and of *Verruca* the carina and the rostrum whose sum is divided by two. The shells of the different species are placed in separate boxes. Character and quantity of the mineral matter are noted. The shells of each species are counted. To facilitate comparison the figures are reduced so as to give number of individuals per liter or per one-tenth liter. These figures are tabulated and published either separately, as by the writer in the paper of 1917, or the sum of the two fractions, as in the present paper in order to save space. Thus the frequency figures in the accompanying tables indicate number of individuals over 1 mm in diameter of the different species in one-tenth liter of shell gravel. For still greater accuracy the shells of the different species may be weighed, as was done by De Geer (1910). In this case all specifically determinable shells and fragments should be picked out. However, weighing of the light shells of the post-glacial beds would usually be impracticable.

Analyses of this kind of a number of samples from different levels in a shell bed furnish objective data as to the composition of the fauna and as to its changes from layer to layer. If the bed proves to be formed largely of shells from molluscs that lived on the spot and to be undisturbed, the changes of the fauna and the material may indicate the nature of the physical alterations that eventually took place during the time of deposition. An upward decrease of d-forms and a corresponding increase of s-forms and pebbles may mean that the bed was deposited during regression — eventually rise of the land. An upward decrease of s-forms and of coarse mineral gravel and increase of d-forms may indicate that the bed was formed during transgression — eventually sinking of the land. A uniform fauna in a thick bed eventually means that transgression took place at the same rate as the accumulation of shells.

However, there are several conditions to be taken into consideration. Hardly any mollusc is strictly limited to a narrow range of water depth. Part of the shells may be downwashed, part redeposited, part upwashed. Increase and decrease, appearance and disappearance of animals may be the result of many causes individually or jointly as changes in bottom, vegetation, exposure, currents, temperature, salinity, percentage of oxygen and of pH, or may be the result of immigration or disappearance of certain forms, overcrowding of certain animals, etc., all changes and conditions that can eventually take place and come into effect by accumulation of shells, etc., without alteration of level. Thus molluscs of the same bathymetrical group often present disagreeing variations of frequency; *Mytilus edulis* may decrease, while *Littorina littorea* increases in number.

It is consequently by no means easy to read the changes of level from the shell beds, especially as our knowledge of the formation of shell beds is unsatisfactory.

IV. Dating of the Shell Beds.

General considerations and means of dating.

Shell beds have been forming in the eastern Skagerack ever since the uncovering from the last ice sheet, i. e., for some 13 000 years.

Retreat of the last ice sheet.

The gradual uncovering from the ice had a marked effect upon the late-glacial marine fauna. Contemporary faunas assumed a more southerly aspect with increasing distance from the ice border. A bed at Göteborg is older than a bed of the same composition in Östfold.

The moraine crossing southern Sweden from north of Kalmar to Göteborg continues northward to the region west of Uddevalla and from there north-northwestward so as probably to reach the modern coast between Gräbbestad and Strömstad (MUNTHE, 1910 a, Pl. 47; 1924, Pl. 3, p. 110; DE GEER, 1910 a). Outside this line the recession was rather slow, judging from the presence of several moraines. Inside the Uddevalla moraine the uncovering was remarkably slow, for the morainic lines converge westward, so that the retreat of some 42 km in the Uddevalla-Vänersborg region up to the Fredrikshall-Håkantorp moraine is in eastern Sweden paralleled by the more than four times greater ice retreat from Kalmar to Söderköping. And the Scandinavian morainic series, including the Fredrikshall-Håkantorp moraine, the Moss-Sarpsborg-Dals Ed-Lidköping moraine, and the intervening lines represent some 860 years (SAURAMO, 1923). North of these moraines the retreat was rapid, for the ice edge withdrew to beyond Lake Mjösa and up to Stugun in Jämtland in some 1 100 years.

Roughly the ice release of the coastal belt of Bohuslän may have commenced some 13 000 to 12 700 years ago. The formation of the Uddevalla-Göteborg moraine may have begun some 12 200, and that of the Fredrikshald-Håkantorp moraine some 10 650 years before our time. The ice border left the Fenno-Scandian moraines some 9 800 years ago (DE GEER, 1914, Pl. 1; 1925). The skerry guard of Bohuslän thus became ice-free some 3 000 to 3 500 years before Aremark — the region northeast of Fredrikshall.

Composition of the fauna.

The general composition of the fauna of a shell bed makes possible a rough dating, as the climatic evolution is fairly well known from the ice recession, immigration and evolution of the land flora, etc. Late-glacial, transitional, and post-glacial beds can generally be distinguished after a superficial examination.

Late-glacial shell beds consist of shells of animals now living in the arctic ocean southward to Vestfinnmark. The number of species is small, but that of individuals of some arctic species is very great. Species that reach their northern limits in the White Sea or south of it are, with few exceptions, poorly represented. The shells of *Saxicava*, the balanids, etc., are now large, now medium-sized and small (cf. p. 541).

Post-glacial shell beds consist of shells of the same fauna as is now living in the Skagerack and in addition of a few forms that have retired to warmer waters. With few exceptions the shells are small, especially those of *Saxicava* and the balanids.

The so-called transition beds from the beginning of the post-glacial age, the Ancylus age, consist largely of small shells of arctic and high-boreal species but contain few shells of early southern immigrants.

For the closer dating of shell beds by means of the composition of the fauna it is important to note that the composition of beds now forming in Bohuslän varies considerably (see p. 518). Observations made by SOOT-RYEN (1924, pp. 84, 105) in northern Norway are also important. In the Ramfjorden, 15 km southeast of Tromsö, the molluscan fauna becomes increasingly arctic with increasing depth of water. South-ranging species are found exclusively within the depth of 20 m, and they predominate between the shore and the depth of 5 m. The cause of this is that the surface layers are warmed up by insolation in summer and that the animals require a certain minimum temperature for propagation, but otherwise are not so particular, as the water temperature is higher at some depth for the greater part of the year. Thus the faunas at different depths present rather different compositions, and, as Soot-Ryen points out, a regression of the shore line a few meters would cause a high-boreal fauna to replace the arctic fauna in the upper part of its present belt. In shell beds formed in situ arctic shell gravel would be overlain by boreal gravel, though no change in the air temperature had taken place. These illustrations of the great variability of the composition of the faunas on account of local conditions show that the composition does not make possible a sure dating and should not be unduly stressed. This is all the more true as the composition at times may be misleading because of downwashing and redeposition of shells or because of the mixing in of new shells in an old bed.

Changes in the composition of the fauna and in the character of the material frequently indicate that the deposition took place during regression or during transgression, so that, if the movements of the shore line are known, the dating of the beds is facilitated. However, the oscillations of level also complicate the matters, for because of them beds at low levels may be older than beds at high levels. The consequence of oscillation is that the age of the beds can only partly be determined by their levels.

Characteristic species.

The occurrence of certain characteristic species may make it possible to arrive at a more definite dating. The species may be characteristic, because they are exceptionally frequent and numerous, because their modern range of distribution falls entirely outside the eastern Skagerack, or because the size and shape vary with the water temperature.

The best example of frequent and characteristic forms is the oyster, which is exceptionally common in shell beds ranging from the sea level to some 15 m above it in Bohuslän and from sea level to 21 m altitude in the inner part of the Oslofjorden (see Björlykke, 1913, pp. 95, 162). The oyster beds may largely date from the last part of the last uplift, as there was no or but slight oscillation of level on the Oslofjorden during the Tapes age.

It should be kept in mind that some of the molluscs supposedly characteristic of a certain age may have been numerous in favorable localities during a great part of the time after the release from the ice. There is the danger of combining and attributing to one period beds that were formed under similar physical conditions but at widely different times. Furthermore, the characteristic shells do not by any means occur in all beds formed during their time of predominance.

Species characteristic because they no longer live in the eastern Skagerack now occur only farther north or farther south.

Among the northern species are *Portlandia arctica* and *Arca glacialis*, now spread southward to the White Sea and Finnmark respectively. In primary position these molluscs occur only in the very oldest deposits, preferably the clays.

Among the southern species *Tapes decussatus*, *Psammobia vespertina*, and *Solecurtus antiquatus* are especially important (cf. p. 557). The two first-mentioned reach their northern limits in the Shetland Islands and the British Isles, respectively, but live as relicts on the Norwegian West Coast. *Solecurtus* extends northward to the Shetland Islands. These molluscs lived in the eastern Skagerack during the climax of the postglacial submergence, at which time a branch of the Gulf Stream reached Bohuslän. As the species of this group are rare, too much importance should not be attached to their absence.

While animals may normally be of subnormal size near their limits of distribution, a few of our species are particularly characterized by variation in size and shape according to the temperature of the water. These are forms preferably living in arctic seas but extending down to relatively low latitudes. Most important are *Saxicava arctica*, *Mya truncata*, and the balanids.

Saxicava arctica, under which are included *S. pholadis* L. and *S. rugosa* L. is represented in the Ice Fjord, Spitsbergen, by animals of all sizes up to a length of 43 mm (ODHNER, 1915, p. 126). In eastern Greenland it is known to become fully 50 mm long, and at Tromsö 32 mm long. In the Skagerack it may seldom exceed 20 mm, but in the Limfjorden is known to reach 38 mm (see HÄGG, 1924, p. 472). The thick-shelled variety *uddevallensis* JEFFREYS is known to live only in the Storfjorden, Spitsbergen.

This writer has no measurements of the shells from Kapellbacken, Uddevalla, where they may be larger than anywhere else. At Brandshult the shells reach a length of 50 mm (BODMAN, 1916; cf. our p. 546; see also HÄGG, 1924, p. 473).

Mya truncata in the arctic seas down to Lofoten has beside the typical form, a variety *uddevallensis* HANCOCK, distinct from the typical form by shorter ventral edge than dorsal edge and generally also by thicker shell (see HÄGG, 1924, p. 470). This variety is found in late-glacial shell beds, as the name indicates.

Balanus crenatus, *B. hameri*, and *B. porcatus* are all larger and have thicker shells in high latitudes and in the late-glacial beds at Kapellbacken than in the temperate seas, at the British Isles, for instance (DARWIN, 1854, pp. 257, 262, 278). *Balanus hameri* is known to reach a length of 90 mm at Hammerfest, which is much more than it attains on the Norwegian West Coast (see HÄGG, 1924, p. 473).

Saxicava and the balanids are large and heavy in the late-glacial beds at Önna, Tossene, Huseby, and Morlanda among those here described. They are partly large in the beds at Noleröd, Tumlehed, Yllene, Lyrö, Stensbo, Knutsdalen, and Sparöd; and medium-sized and small in the beds at Skistad, Nordby, Hästekälla, and Slätthult, and in Aremark. Parallel with the greater size goes a greater relative frequency, so that the large shells of these species form the bulk of the late-glacial shell gravel.

Thus all thick and large shells of the one species found on the Skagerack may originate from the time subsequent to the release from the ice; but not all medium-sized and small shells originate from the post-glacial time. The size of the late-glacial shells seems to have been determined by a combination of factors, among which water temperature, salinity, and food-supply were particularly important.

Width of the faunistic belts.

One of the chief difficulties in dating and correlating the late-glacial beds is our ignorance regarding the width of the then faunistic belts in the area. One is constantly confronted with such questions as: How closely did *Littorina littorea* and the associated fauna approach the ice border? Which beds in central Bohuslän are contemporaneous with the Aremark beds? It seems as if the truly high-arctic fauna at the ice border normally formed only a narrow zone, and as if the low-arctic fauna formed a rather wide belt on account of the equalization of the temperature by the water circulation.

Clay layers.

Clay layers associated with shell beds are sometimes a good help in dating. The clays at Torseröd, Otterö, and Udden II, for instance, may have been formed during the climax of the Tapes submergence, and the underlying and overlying shell gravel may date from the time before and after this subsidence.

Situation in relation to limits and transgression.

The situation of the shell beds in relation to known limits of transgression, especially the uppermost marine limit and the Tapes limit, also facilitates their dating. All beds occurring above the Tapes limit, for instance, are older than the beginning of this transgression. The oscillations of level, on account of which some low beds are older than some high ones, make great caution necessary.

Starting points for dating.

In dating the shell beds a beginning has been made from beds whose age is definitely known, in the first place, namely, from the oldest beds in the region of Göteborg and in Aremark and the highest Ancylus beds in northern Bohuslän.

Gothi-glacial deposits in the Göteborg region.

The first shell-bearing sediments to be formed after the release from the ice were clays with *Portlandia arctica*, *Arca glacialis*, *Macoma calcaria*, and other species dispersed up into the high arctic regions (MUNTHE, 1924, p. 125; DE GEER, 1910, p. 1157) The Portlandia fauna may have lived at the very ice border and followed the ice as it retreated. Next shelly clays without *Portlandia arctica* were deposited (MUNTHE, 1924, p. 129). These clays are recorded at from an altitude of 78 m, or 80 per cent of the marine limit, down to sea level. One of them contains only animals that are met in the high arctic regions, but all the others present *Mytilus edulis* now extending to the west coast of Novaya Zemlya. Several of them also have *Verruca stroemia*, which is dispersed as far as the entrance of the White Sea and Spitsbergen. Finally, one of them contains *Lacuna divaricata*, *Littorina littorea*, and *Zirphaea crispata*, now extending as far as the White Sea. Thus the temperature of the water in which these clays were formed was comparable to that now prevailing in the Barents Sea east of the Kola Peninsula.

Simultaneously with the deposition of these clays real shell beds began to be formed at places where no clay, or but little, settled, i. e. normally in shallow water. Late-glacial shell gravel has been observed between the levels of 70 and 25 m, or 72 and 28 per cent of the marine limit (Munthe, 1924, p. 131). All of the shells contain *Mytilus edulis* and one or more warmer species, viz. *Balanus hameri*, *Homalogyra atomus*, *Lacuna divaricata*, *Littorina littorea*, *L. rudis*, *Macoma baltica*, *Onoba aculeus*, and *Verruca stroemia*. They indicate a water temperature like that at Kolguev Island and in the White Sea at the present time.

Thus, according to Nils Odhner's and Munthe's studies, the warmer species make their appearance in the Göteborg region at the following levels:

	Height in m	Per cent of marine limit	Gravel	Clay	Northern limit
Mytilus edulis	78	80	—	+	Novaya Zemlya
Macoma baltica	70	72	+	—	Kolguev I.
Littorina rudis	70	72	+	—	Spitsbergen
› *littorea*	55	64	+	—	White Sea
Lacuna divaricata	55	59	+	—	› ›
Verruca stroemia	37	42	—	+	East Murman
Balanus hameri	25	30	+	—	White Sea
Onoba aculeus	25	30	+	—	Spitsbergen
Zirphaea crispata	25	30	+	—	White Sea

All these shelly deposits in the Göteborg region were formed during the rise that followed directly upon the release from the ice, were formed in Gothi-glacial time.

The relative poverty of life in the eastern Skagerack at this time, both as regards individuals and species, may be due to scarcity of food; for, as Clark (1927, p. 242) points out, life in the sea is largely dependent on foodstuffs brought down from land, and the land, newly uncovered from the ice, had not yet acquired a vegetation so dense that really large quantities of vegetable matter were washed into the sea.

Fini-glacial beds in Aremark.

The late-glacial beds in Aremark, the region northeast of Fredrikshall occur between 165 and 90 m altitude (Öyen, 1908, p. 107; Rekstad, 1922, p. 20). The average height of the marine limit is 175 m. The beds described in the present paper range from 150 to 93 m in altitude (see p. 583). They contain a fauna consisting of 21 ax-forms, 14 a^1x forms, and 1 b-form — *Axinus sarsi*. *Axi-*

nus is to the writer's knowledge not recorded north of Vadsö. The ax-forms are species common in the high-arctic seas. The a^{1}x forms are:

	Northern limit
Anomia aculeata	White Sea
» *ephippium*	»
Cyprina islandica	»
Gibbula tumida	Murman
Lacuna divaricata	White Sea
Littorina littorea	»
» *rudis*	Spitsbergen
Macoma baltica	Kolguev Island
Mytilus edulis	Novaya Zemlya
» *modiolus*	Kara Sea
Onoba striata	Spitsbergen
Tectura virginea	Murman
Verruca stroemia	East Murman
Zirphaea crispata	White Sea

Ancylus bed in northern Bohuslän.

The shell bed at Bredhult (cf. p. 600), 9.5 km north of Strömstad, occurring at 71 m of altitude surely lies above the Tapes limit, which here according to Brögger (1905), runs at some 45 m and according to De Geer (1925, p. 22) at 50 m. The bed is composed of 11 ax-forms, 13 a^{1}x-forms, 5 bx-forms, 3 b^{m}x-forms, and 1 b^{1}x form. The most southerly species are *Ostrea* dispersed northward to the Trondhjemsfjorden and *Lunatia intermedia*, *Parthenia interstincta*, and *Thracia papyracea* extending to Lofoten. The bed is evidently of Ancylus age.

Dating of the shell beds.

Late-glacial beds.

The shell beds Noleröd, Önna, Tossene, and Tumlehed suggest vater temperatures as at present in the eastern Barents Sea from Novaya Zemlya to the White Sea. They are comparable to the eds at Göteborg and apparently also date from the uplift following directly upon the release from the ice. When the Tumlehed ed was formed the sea level in the Göteborg region may have stood some 25 to 30 m higher relative to land than today, may ave stood at about 35 per cent of the marine limit.

From Brandshult, 24 km south of Göteborg and 2 km southeast of Särö, a bed has been described by BODMAN (1916). It lies 7 m above the sea. It presents the section:

Topmost. 1.4 m shell gravel, consisting of redeposited late-glacial shells and of post-glacial shells.
0.6 m shell gravel colored brown by organic matter.
3.5 m uncolored late-glacial shell gravel.

The fauna of the uncolored late-glacial gravel is composed of 17 ax-forms and 11 a¹x-forms. The former ones are common high-arctic species. The latter ones are: *Balanus hameri*, *Hydrobia ulvae*, *Lacuna divaricata*, *Littorina obtusata*, *L. palliata*, *L. rudis*, *Mytilus edulis*, *M. modiolus*, *Onoba striata*, *Tectura virginea*, and *Verruca stroemia*. Of these *Hydrobia* and *Tectura*, now extending to the White Sea and the Murman Coast respectively, are not found in the beds just mentioned or in those as Göteborg. The shells of *Saxicava* are partly large, up to 5 cm long, but mostly medium-sized, 3 to 4 cm long. The somewhat more southerly character of the Brandshult bed may be due to its formation much farther from the ice border and to slightly younger age. The fact that the bed may have been formed at a time when the shore line stood some 15 m higher than today fixes its age at the transition between the Gothi-glacial and fini-glacial ages (cf. p. 000). The bed thus may have been formed contemporaneously with the oldest beds at Kapellbacken. It is not late fini-glacial, as BODMAN concludes from the similarity with the shell beds in Aremark, which region was first uncovered several thousand years later.

The Kapellbacken beds, 1 km south of Uddevalla, described by DE GEER (1910), extend from 10 to 70 m above sea level. The complete series of strata is:

Topmost, up to 1 m thick shell-free clay. Observed at localities E28, F42, and G50 (pp. 1157, 1160, 1167).
Up to 5 m thick late-glacial shell gravel (p. 1152).
3 m fine clay with *Portlandia arctica*, *Arca glacialis*, *Macoma calcaria*, etc. (p. 1157).

A bed, L46, with a warmer fauna rests on a clay considered by DE GEER (pp. 1159, 1171) to be probably the upper clay in the series. A clay at Marieberg, just north of Uddevalla, containing arctic molluscs and resting upon a shell bed of the same kind as those of Kapellbacken, is believed by DE GEER (p. 1148) to be contemporaneous with the upper clay in the profile.

Besides molluscs characteristic of the high-arctic seas the following ones are recorded in the late-glacial Kapellbacken beds (De Geer, 1910. Table A): *Mytilus edulis*, extending to Novaya Zemlya; *Macoma baltica*, extending to Kolguev Island; and *Anomia ephippium*, *Balanus hameri*, *Lacuna divaricata*, *Littorina littorea*, *L. palliata*, *Zirphaea crispata*, and *Verruca stroemia* all extending northward to the White Sea. *Thracia papyracea* and *Jeffeysia opalina*, extending to Lofoten and the Shetland Islands respectively and mentioned in the table, have too southerly a distribution to fit into the community and should probably be left out of consideration. The material consists largely of shells of balanids, especially of large shells of *Balanus hameri*, and of *Saxicava*. The shells of *Balanus porcatus* are also large and thick.

Shells of *Mytilus edulis* mostly play a subordinate rôle, and this decreases upward except in F42. From this, and from the fact that the shell gravel resting directly on the fine lower clay at places contains pebbles 1 to 1.5 cm in diameter, De Geer (p. 1167) concludes that the shell beds began forming in very shallow water and that the deposition proceeded during transgression of the sea — a transgression during the fini-glacial age.

As regards the composition of the faunas the Kapellbacken beds are like or slightly colder than the Aremark beds. They indicate water temperatures as in the White Sea at the present time, while some of the Aremark beds suggest conditions as on the western Murman. As the Kapellbacken beds besides lie much farther from the center of the ice sheet they must be older than the Aremark beds. The Kapellbacken beds have large shells of *Saxicava*, balanids, etc., while the Aremark beds have medium-sized and small shells. If the large and thick shells are due to low water temperature, the former beds must be much older than the latter, must be of Gothi-glacial age. This reasoning and other things led the present writer (1921, p. 644) some years ago to place the Kapellbacken beds and the land-sinking they suggest in the Gothi-glacial epoch. This view is now abandoned. The small size of the shells of *Saxicava*, balanids, etc. in most late-glacial beds may at any rate largely be due to other causes than high temperature (cf. p. 542). Therefore, and because the water temperatures must have been much the same at Kapellbacken and in Aremark, the Kapellbacken beds may be only a little older than those in Aremark. Thus the former may be either of late Gothi-glacial or early fini-glacial age. As terraces, marine limit, etc. in Dal and Västergötland indicate land sinking in fini-glacial time (p. 572), the Kapellbacken beds may date from the first half of this epoch as held by De Geer.

None of the beds described in this paper is surely from the fini-glacial transgression, of the same age as the Kapellbacken beds. Slätthult and Stensbo might be derived from this sinking, but they date more probably from the subsequent rise, judging from their faunas, the smaller size of the shells, etc. During the time of deposition of the Kapellbacken beds *Saxicava* and the balanids should, it seems, have grown to large size in the skerry guard of central Bohuslän.

Sparöd, Slätthult, Yllene, Skistad, Nordby II, and Hästekälla have about the same faunas as the Aremark beds, which date from the middle and latter part of the fini-glacial age (see p. 544). The shells of Saxicava and the balanids are largely medium-sized and small. Sparöd, Yllene, and Nordby II may have been formed during regression, judging from the changes that their compositions undergo upwards, etc. Thus all of these beds may date from the uplift during the latter half of the fini-glacial epoch. The relative age of the beds is approximately given by their positions as to the marine limit.

Lur, Lyrö, Stensbo, Sanderöd, Lavö, Glimsås, and Huseby present faunas indicating a water temperature such as now exists in the region from western Murman to Lofoten. The shells of *Saxicava*, etc. are mainly small. These conditions as well as the altitudes at which the beds occur suggest that the beds date from the latter part of the fini-glacial uplift.

Morlanda, Hermanö, and Tången have faunas such as are now to be found in the Öksfjorden and at Lofoten, and they come close to the previous group. As regards composition and altitude the beds form a complete series from Sparöd at 66 m altitude down to Tången at modern sea level.

Beds from the Ancylus transgression.

Gudebo (p. 598) at 48 m altitude was probably deposited during a transgression that may have reached above the Tapes limit. It contains a few low-boreal species and may thus date from the submergence in middle Ancylus time. Skårbo and Knutsdalen (p. 599) whose faunas suggest water temperatures like those at Lofoten and Kvænangen today respectively propably are derived from the same sinking, as they are essentially warmer than the beds at corresponding levels formed during the previous late fini-glacial rise and colder than the beds from the late Ancylus regression.

The Stångenäs bed (Hägg, 1924), 15 km north of Lysekil and at 45 m height, in which two human skeletons embedded as the shell gravel accumulated were found in 1843, may also belong to this age of subsidence to judge from the general composition, which indicates a water temperature like that in the region Lofoten-Tromsö today.

Kapellbacken L46, described by De Geer (1910, pp. 1159, 1171; Pl. 43, Table B), has a fauna such as is now found at Vannöy north of Tromsö. The variation of frequency of the characteristic molluscs indicates deposition during increasing rather than decreasing water depth, as held by De Geer. The bed may therefore date from the Ancylus sinking.

Beds from the late Ancylus regression.

Besides Bredhult, Skärjedalen and Skärje (pp. 545, 601), at 63 and 60 m altitude respectively, may lie substantially above the limit of the Tapes transgression, which here probably falls at or below 50 m altitude. Their faunas indicate water temperature such as exist in the Trondhjemsfjorden today. The Bredhult bed suggests deposition during regression of the shore line. The two other beds also may be derived from the early part of the late Ancylus regression.

Oxtorp, Ullerö, and Tose (p. 603) also probably lie above the Tapes limit. They contain a few low-boreal forms and may come close to the beds just mentioned.

Several examined beds occurring below the Tapes limit down to the modern shore contain a few low-boreal molluscs in subordinate numbers. They lack the host of the modern south-ranging species. Some of the deposits even lack all low-boreal molluscs in the bottom strata but have them in increasing numbers towards the top. These deposits are thus rather different from the sure Tapes beds and the modern beds in which low-boreal shells play a dominating or very prominent rôle. They may date from the last part of the Ancylus age. The dating of a few of the beds, as Klevekilen I, Fossa, Sörgården, and Näset A, is facilitated by the sequence of the strata.

Beds from the Tapes sinking and the subsequent rise.

In the early Tapes or Littorina age the bulk of the south-ranging molluscs had arrived in the eastern Skagerack, and from that time on the faunistic composition of the beds can only occasionally serve as a means of closer dating. Only in exceptional cases do the beds from the different ages differ more from each other than do beds formed in different situations during each stage. However, the beds at low levels characterized by a large percentage of oyster shells may largely date from the latter part of the last uplift — the uplift after the Tapes sinking (p. 580), though rich oyster beds undoubtedly were formed in favorable situations during the greater part of the post-glacial age.

The majority of the late post-glacial beds described may be from the last uplift; but several of them probably date from the Tapes sinking, though only a few suggest by their sequence of strata and faunistic variations that they do so. The beds that cannot be dated with reasonable certainty have been attributed to the last uplift, this being the conservative course to take. Thus, some of the beds may be older and some molluscs may eventually be earlier immigrants than the tables indicate.

V. Dispersal of Molluscs, etc. and Immigration to the Eastern Skagerack.

Mode of dispersion.

The great majority of the marine molluscs are spread during the larval state by free-swimming veliger larvae. Exactly how long the larvae swim about before they settle on the sea bottom and develop to molluscs seems not to be known (cf. GARDINER, 1904), but they do so for a "considerable period" of time (JOHNSTONE, 1908, p. 86). They may then be carried by currents and waves fairly long distances, which makes possible a rapid dispersion of the species. A good example is the diffusion on the east coast of North America of the recently introduced *Littorina littorea* (VERRILL, 1880; GANONG, 1886). The species was first observed at Halifax, Nova Scotia, in 1857. It appeared in Maine about 1868; at Provincetown, Cape Cod, in 1872; at Woods Hole, Massachusetts, in 1875; and at New Haven, Connecticut, in 1879—1880. In 1875 it was common at Provincetown, and in 1879 exceedingly abundant. In 1886 it was very abundant from the Gulf of St. Lawrence to Connecticut. In the Limfjorden, Denmark, a Macoma baltica community with *Mytilus edulis*, *Littorina littorea*, *Cardium edule*, *Mya arenaria*, *Hydrobia ulvae*, etc. was established as early as 1832, i. e., seven years after the breaking through of the sea in 1825 (SPÄRCK, 1922, p. 83).

Animals that are permanently fixed in the adult state as the oyster, or attached by a byssus as *Mytilus*, or with a muscle as *Anomia* are only spread as larvae.

On the other hand many molluscs have larvae which are not pelagic. So some gastropods produce eggs that are enclosed in cocoons and do not float about. Such molluscs are dispersed as developed animals, as are also of course most of those that have pelagic larvae. The ability of locomotion of the developed animals, however, is so limited that hardly any of them can be regarded as migratory, hardly even *Solen* and the Amphineurae, which have greater rapidity of movement than the others (FRASER, 1918, p. 140).

The dispersal of developed animals may therefore largely take place in a passive way, by means of plants and occasionally by ice. The power of flotation of common seaweeds is remarkable. *Fucus nodosus* has been kept floating in vessels of sea water for 11.5 weeks, *F. serratus* for nearly 7 weeks, *F. vesiculosus* for 5 weeks, and *Zostera marina* for as long as 3 days (VALLENTIN, 1895, p. 419). Fucus has been collected in abundance floating in the North Sea at long distances from land (VALLENTIN, 1885, p. 418). It is especially during storms in the autumn that plants become detached and set afloat. A seaweed may be driven several miles during a single tide. A living *Cardium edule* was observed on a drifting frond of *Chorda filum* 1.5 km from land (VALLENTIN, 1895, p. 420). As a number of molluscs preferably live on seaweeds and among the roots of zostera, and as algae frequently are attached to large shells, it seems reasonable to assume that seaweeds form the chief means for dispersal of such molluscs as lack pelagic larvae.

The crustaceans cirripeds, represented in the shell beds by *Balanus* and *Verruca*, are sessile in the adult state and are spread as larvae, these being pelagic (JOHNSTONE, 1908, p. 85; SMITH, 1909, p. 80). The first liberated larvae, nauplii, swim freely near the surface of the sea for several days and are dispersed widely from their birthplace. They are then transformed into cypris larvae, which continue to swim about until they find a suitable place to settle. To an insignificant extent such specimens as settle on animals and objects like molluscs, ships, pebbles, etc. are spread passively.

The brachiopods are stationary in the adult stage, possessing locomotion only as larvae (SHIPLEY, 1895, p. 481). The larvae spend only a short time in a motile condition. They may not swim a meter in an hour, but may, of course, be carried by currents a long distance in that time. The dispersal of brachiopods is very slow, as shown by their extremely localized occurrence.

Occurrence of the molluscs during the climax of the glaciation.

During the maximum of the glaciation the part of the modern North Sea that was not occupied by land or by the ice sheet no doubt formed an arctic sea with ice floes. *Portlandia arctica*, now reaching its southern limit in the White Sea, then lived on the east coast of Scotland (Jamieson, 1865, p. 197).[1]

On the west coast of Scotland, in the Firth of Clyde, lived a molluscan fauna comparable to that in Vestfinnmark today, as recorded by shelly deposits at about 6 m above the sea (Jamieson, 1865, p. 201). The fauna mostly contains species spread from the high-arctic or low-arctic regions down into the low-boreal or lusitanian regions together with some forms of a more limited range. Of these latter a few, as *Macoma calcaria*, *Pecten islandicus*, and *Trophon clathratus*, now reach their southern limits in the Scandinavian waters, while others, like *Cardium edule* and *Tellimya ferruginosa*, have their northern limits in Vestfinnmark.

The oldest late-Quaternary marine fauna on the continental side of the Strait of Dover, found by borings down to 33 m below sea level, indicates but slightly lower temperature than now prevails in the strait (Dubois, 1924, pp. 139, 144, 310). The few northranging species represented, with the exception of *Trophon* (*clathratus?*), are now dispersed south of the English Channel. This fauna is thus very much warmer and consequently much younger than the land fauna during the climax of the glaciation, which includes mammoth and reindeer (Dubois, 1924, p. 275). The marine fauna contemporaneous with the mammoth is evidently to be sought on the English Channel at much greater depth below sea level than 33 m. It is thus probable that the modern boreal molluscs of the North Atlantic and the North Sea survived the climax of the last glaciation on the west coast of France and possibly Portugal.

Routes of migration. Sea currents.

On account of the low stand of sea level and (or) high stand of land greater or less parts of the Strait of Dover and the southern North Sea may have formed land from long before the climax of the last glaciation till the beginning of the postglacial age (see p. 566). The early molluscan immigrants to the Skagerack may therefore either have been derived from the northwestern part of the North Sea or have come from the Atlantic around the north of Scotland.

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[1] The shelly ›glacial› beds described by Jamieson from the East of Scotland between the Moray Firth and the Firth of Forth may be of rather varying age, as some contain *Aporrhais pes pelicani*, *Cardium edule*, *Nassa incrassata*, and other species which now reach their northern limits of distribution in Vestfinnmark.

It has been supposed by various writers that the Gulf Stream did not cross the Wyville Thomson Ridge between Scotland and the Faeroe Islands until the beginning of the fini-glacial age. However, if the Gulf Stream really existed, there is no obvious reason why it would not have entered the North Atlantic earlier, for the water depth on the ridge, now fully 500 m in places (Schott, 1926, p. 127), may not have been less, during the climax of the glaciation, than 400 m.

Already during the Dani-glacial stage the sea may have risen enough to begin to inundate the isthmus at Dover and change it into a narrow strait, for the water depth on the threshold between Dover and Calais now reaches about 50 m. However, since in a broad belt between England and Holland north of the 53rd parallel of latitude the water depth is less than 35 m, no gateway to the Scandinavian seas may have been opened here until much later. During the Ancylus age the shore line at Calais, according to Dubois (1924, p. 313), stood some 15 m below the modern position.

The currents, which of course have been the chief agencies of dispersion of the shellfish, must have changed with the outline and depth of the North Sea. When the north end of the Danish Peninsula was submerged the currents had freer access to the eastern Skagerack. Thus, during the Tapes transgression the Gulf Stream touched the Swedish shores for the only time, as shown by a bean of the West Indian plant *Entada scandens* that was washed ashore and preserved at the base of a peat bog (Andersson, 1910, p. 293).

At present a small branch of the Gulf Stream enters the North Sea through the English Channel. A larger branch is deflected at the Shetland Islands and flows southward along the British east coast, eastward off Holland, and northward along Jylland (Helland-Hansen and Nansen, 1909, p. 9; Böhnecke, 1922; Schott, 1926, p. 200). Without reaching the Swedish coast it turns north of Skagen and follows the Norwegian coast westward and northward.

Time of immigration.

The time of arrival of the various molluscs at the eastern Skagerack, as far as determined by these studies and as far as the dating of the shell beds is correct, is given by their first representation in the main tables, in which the beds are arranged according to age.

When immigration began, as the ice withdrew, it started much earlier in Bohuslän than in southeastern Norway. The order and time of arrival of the animals was largely determined by the temperature of the water. Rare species may, of course, be mistaken by being considered as later immigrants than they actually were. Species dispersed into the arctic region began immigrating immediately upon release from the ice sheet. *Mytilus edulis*, *Macoma baltica*, *Littorina littorea*, *L. rudis*, *Lacuna divaricata*, *Verruca stroemia*, etc., arrived in Gothi-glacial time (p. 544). Forms extending to Finnmark, as *Cardium edule*, *C. exiguum*, *Corbula gibba*, *Gibbula cineraria*, *Lepidopleurus asellus*, *Montacuta bidentata*, *Parthenia spiralis*, *Solen ensis*, and *Venus ovata*, and a few species reaching Lofoten, viz., *Abra alba*, *Actacon*, and *Thracia villosiuscula* appeared during the later half of the fini-glacial age.

The immigration was slow. Of forms reaching their northern limits in or south of the Trondhjemsfjorden, *Nassa reticulata*, *Ostrea*, and *Tapes aureus* appeared during the Ancylus transgression, if the Gudebo bed is correctly dated. Several southward-ranging species arrived during the early part of the Ancylus regression. Most important among these in order of appearance are: *Lepton nitidum* (Skärjedalen), *Hinnites pusio* (Skärje), *Cardium norvegicum* and *Tapes virgineus* (Oxtorp), *Bittium reticulatum* and *Rissoa parva* (Ullerö), and *Odostomia albella-rissoides* (Tose). However, with single exceptions the low-boreal molluscs played a subordinate rôle both as regards number of species and individuals until the last part of the Ancylus regression. Then *Lasaea rubra* and *Pecten varius* (Klevekilen I) and *Mangelia costata* (Ellene) appeared. *Psammobia vespertina* and *Tapes decussatus* (Udden II) which now have withdrawn from the eastern Skagerack arrived during the Tapes transgression. *Mya arenaria* and *Lucina spinifera* are first represented in modern beds. The time of immigration of the common *Balanus balonoides* is unknown, as old shells of it cannot easily be distinguished from old shells of *B. crenatus*.

The majority of the post-glacial immigrants seems to have appeared at about the same time in Bohuslän and southeastern Norway; while some, judging from the present studies and those of Brögger (1901, pp. 652—662), may have arrived earlier here, others earlier there. Contemporaneous immigrants among others are: *Bittium*, *Ostrea*, *Pecten varius*, *Psammobia vespertina*, *Rissoa parva*, and *Tapes decussatus*. Earlier on the coast of Bohuslän were: *Cardium norvegicum*, *Lasaea rubra*, *Lepidopleurus asellus*, *Lepton nitidum*, *Odostomia albella-rissoides*, *Tapes aureus*, etc. Earlier in the Oslofjorden appeared: *Lucina spinifera* and *Pecten opercularis*.

VI. The Climatic Testimony of the Fauna.

Water temperature the climatic factor.

Temperature is, practically speaking, the only climatic factor that has any influence upon marine organisms, and it is consequently the only one regarding which subfossil shells give any information. Provided no land barriers or wide oceans prevent dispersal, provided salinity, light, percentage of oxygen and of pH are normal, provided bottom and exposure are favorable, etc., temperature is the most important factor determining the limits of distribution of marine organisms; and it has generally been taken as the basis for their geographical classification.

The aspect of the water temperature that it decisive is different according to species and conditions. In general the daily and yearly amplitudes are most important (Maas, 1894, p. 278; Ortmann, 1896, p. 36). Each species has a minimum, an optimum, and a maximum temperature of existence. Some species can endure only slight fluctuations—stenothermal species; others can stand considerable variations—eurythermal ones. At Woods Hole, on the southern coast of Massachusetts, actual destruction of adult animals may occur as a result of extreme cold in winter. The unusual cold winter of 1917—1918 had a very marked effect on the fauna, (Allee, 1923 a, p. 354; also Sumner, etc. 1911, p. 177). The effect of winter killing is thought by Allee to be the principal factor in limiting the northward distribution of south-ranging littoral invertebrates. The southern extension of the north-ranging species is, according to the same writer, limited by the high summer temperatures of the mud flats and tide pools which can kill the animals. It has been found, however, that animals of the same species can live at very different temperatures, at 3°, 7°, and

15° C., if only this temperature at the respective localities remains fairly constant at 3°, 7°, and 15° C. (MAAS, 1894, p. 278).

In the Ramfjorden, southeast of Tromsö, the temperature during the summer months is decisive for the existence of south-ranging molluscs. This is evident from the fact that these molluscs are limited to the shallow waters that are warmed by the summer insolation, although the temperature during the greater part of the year is higher at some depth (SOOT-RYEN, 1924, p. 84). The occurrence of these molluscs may be determined by a necessary minimum temperature for reproduction, which is one of the really important factors in determining the distribution of marine animals. This minimum temperature can be a lowest degree or a lowest sum of temperature. While it was held earlier that the development of oyster eggs began at a temperature of 15° to 16° C. and proceeded as long as the temperature remained above this figure (ORTON, 1920, p. 361), it now seems probable that the egg development is a product of time and temperature (ORTON, 1927). However, the time of breeding of the species is seven or more months of the year in its southern and warmer habitats, and only one or two months, or even none in some years, in its northern habitats. The breeding temperature is specific. There are many animals in temperate waters that breed during the coldest months. *Littorina palliata* at Woods Hole, for instance, lays eggs nearly or quite all the year round (SUMNER, etc. 1911, p. 176).

Molluscs as indicators of temperature.

The composition of the fauna of a shell bed gives a general idea of the water temperature during the time of formation. However, a great number of the molluscs have a wide north-southerly range, are perhaps distributed from the Arctic to the Mediterranean, and evidently tell nothing as regards the actual temperature in the Skagerack. It is the poorly represented emigrants and immigrants, and the outposts at and near the geographical limits of the species, that indicate the temperature more definitely.

Among the indicators of the temperature in the Skagerack in late-glacial time there are in the first place such animals as at present have their southern limits north of here. Such forms are *Arca glacialis*, *Cingula castanea*, *Littorina palliata*, *Modiolaria corrugata*, *Portlandia arctica*, etc. (see p. 543). For instance, *Portlandica arctica*, now ranging from the polar regions down to the White Sea, shows that the water temperature near the ice border was like that existing today in the White Sea or farther north.

Other especially important indicators of temperature are those forms that now are to be found only in warmer waters than the Skagerack. Most important among these are *Donax vittatus*, *Lepton squamosum*, *Pholas candida*, *Psammobia vespertina*, *Solecurtus antiquatus*, and *Tapes decussatus* (HÄGG, 1924, p. 477; our p. 541). For instance the occurrence of *Tapes decussatus* in shell beds indicates that the water temperature in the eastern Skagerack once was at least as high as it is today at the Shetland Islands and Holland.

A few species now dispersed down into the temperate, or even warm, seas but thriving particularly well in arctic waters, develop much larger and thicker shells here than in lower latitudes. Most important among these are *Saxicava*, *Balanus porcatus*, and *Mya truncata.* The southern limit of the heavy shells lies about at Lofoten (cf. p. 541). Large shells of these species consequently indicate lower temperature than at Lofoten today. On the other hand, however, medium-sized and small shells do not necessarily mean that the water was warmer than at Lofoten, for the size of the late-glacial shells in the Skagerack was to a great extent determined by salinity, food supply, etc. (cf. p. 542).

A subnormal size of the shells at the extreme limits of occurrence of the species is common and of climatologic significance. *Modiolaria nigra*, distributed from the polar regions to Holland, is scarcer and distinctly smaller on the Norwegian West Coast and in the Skagerack than in the Arctic. However, in the southern Kattegatt and in the Öresund it is again common and as large as in the polar seas (VON HOFSTEN, 1913, pp. 110, 112). Also *Lepeta caeca* is smaller and scarcer in the Skagerack than in arctic waters. The last late-glacial survivors of *Portlandia arctica* in the Skagerack area were dwarfed, probably because of too high temperature and too diluted water. The earliest immigrants of some species, as represented in the shell beds, were more or less stunted.

It is important that several molluscs probably have not yet reached their natural northern limits, since they were driven southward during the glaciation, but that they tend to indicate higher temperature in the late-glacial Skagerack than actually prevailed. Absence of molluscs does not necessarily mean that they cannot endure the natural conditions. *Mya arenaria*, now common on the Scandinavian coasts as far as the White Sea, did not arrive in Scandinavian waters until after the end of the last regression, as is seen from the fact that it is lacking in the raised deposits. There is no obvious reason for this late immigration.

Relicts.

While several really arctic molluscs that were driven southward to the Skagerack during the glaciation have long since left, a few still remain there. These are species of great adaptability which have been able to accommodate themselves to the gradually rising temperature and the accompanying changes in other respects. Though very scarce south of Lofoten, some molluscs occur at several places scattered along the Norwegian coast, so that they can be said to have a continuous distribution down to the Swedish waters. Examples are *Lepeta caeca* and *Modiolaria nigra* (VON HOFSTEN, 1913, p. 110).

One or two species show a decided break in their distribution, occurring in isolated colonies as glacial survivors or relicts. A definite relict is *Astarte borealis*, and a probable one is *Pecten islandicus* (VON HOFSTEN, 1913, pp. 109—119). *Astarte borealis* has its southern limit at Lofoten. One living specimen has been found at Bergen; and the species is recorded from the central North Sea It is lacking in the Skagerack but is scarce in the southern Kattegatt and common in the Danish sounds and the western Baltic. The area in southern Denmark is thus well isolated from the continuous region in the Arctic. *Pecten islandicus* has an unbroken distribution from Spitsbergen and Novaya Zemlya to Lofoten. South of this point it is common in the Trondhjemsfjorden and is recorded by a few stunted specimens from Bergen, Stavanger, and Bohuslän.

Since the post-glacial temperature maximum some southern species have entirely withdrawn from the eastern Skagerack. Others, like the oyster, have greatly decreased in frequency. Still others have perhaps been isolated so as to become southern relicts.

Evolution of temperature in the eastern Skagerack.

In Gothi-glacial time the Skagerack formed an ice sea. It was bordered in the north and the east by the ice sheet which released masses of icebergs and poured enormous quantities of ice-cold melt water into it. It was first inhabited by a high-arctic fauna including *Portlandia arctica* and *Arca glacialis* which have their modern southern limits in the White Sea and on Finnmark, respectively (p. 543).

In the later part of the Gothi-glacial age the water temperature in southern and central Bohuslän, judging from the molluscan fauna, was like that today in the Barents Sea east of the Kola Peninsula (p. 543). On the transition between the Gothi-glacial and the fini-glacial ages the temperature at Brandshult, south of Göteborg, was like that off the Murman Coast (p. 546). During the first half of the fini-glacial time, at Uddevalla it was as now in the White Sea (p. 547). At the middle of the period mentioned the temperature in southern Östfold was like that off Kola (p. 545). In the later half of the same epoch the water temperature off Bohuslän rose so as to become like that at Lofoten at present. The temperature rise proceeded gradually, so that the water at the end of the Ancylus age was much as it is today.

During the Tapes submergence the water temperature became higher than at present, as especially shown by the presence of *Psammobia vespertina* and *Tapes decussatus*. The former has its present northern limit at Scotland and occurs as a relict at Bergen. The latter extends up to the Shetland Islands and lives as a relict on the Norwegian west coast as far as the Nordfjorden. At the climax of the transgression *Solecurtus antiquatus*, which now extends as far as the Shetland Islands, appeared in the Swedish waters (ANTEVS, 1917, pp. 267, 302); and during the subsequent regression *Donax vittatus*, *Lepton squamosum*, and *Pholas candida* immigrated (HÄGG, 1924, p. 477). *Donax* now extends to Aberdeen and Skagen; *Lepton* to Anglesey and the eastern part of the English Channel; and *Pholas* to northern Scotland and Skagen. *Pholas* was recently found living at Trondhjem (DONS, 1927).

Beside these, several other molluscs that have recently withdrawn to warmer regions inhabited the Swedish waters during the Tapes age. In shell beds from the climax of the Tapes transgression (HÄGG's upper Tapes beds) 4 such south-ranging species and in beds from the Tapes regression (HÄGG's lower Tapes beds) fully 18 such species have been found by HÄGG (1924, p. 479). The forms that have now disappeared seem to have remained towards the end of the last regression. During the Tapes regression 71 warmth-loving molluscs immigrated to Bohuslän according to HÄGG. During the last part of the regression the oyster was remarkably frequent.

The fossil molluscan fauna consequently shows that the water temperature in the eastern Skagerack was higher than now from early Tapes time till about the end of the last uplift during the Bronze age, i. e. roughly from 7 000 to 3 000 years ago. According to the testimony of the land flora, the air temperature of northern Europe was higher from about 7 000 to 3 500 or 2 500 years ago (SANDEGREN, 1924 a, pp. 43, 52).

The mean annual temperature of the surface water is now: on the coast of Bohuslän about 8° C., at Skagen 9°, off Holland 10° to 11°, on the Norwegian west coast 8.5°, at the Shetland Islands and on the east coast of Scotland 9°, and at Anglesey 10.5° (THOMPSON, 1916, Fig. 4). The mean water temperatures at the modern northern limits of the south-ranging species mentioned are thus from 1° to 2° C. higher than at Bohuslän. The decisive aspect of the temperature for the molluscs is probably a combination of the minimum temperature and the seasonal fluctuations of the temperature. The mean minimum temperature, which decreases strongly with proximity of land and distance from the open ocean, is 6° C. at the Hebrides and Shetland Islands, 5° on the Scottish and English east coast, 4° off Holland and the Norwegian west coast, 2.5° at Skagen, and below 2° off Bohuslän and the Oslofjorden (THOMPSON, 1916, Fig. 9). The mean annual range of the surface temperature increases from 6° C. at the Hebrides and the Shetland Islands to 10° at Hull and Bergen, 14° off Holland and at Skagen, and still more at Bohuslän. The maximum temperature, if 12° to 13° C., seems to play a smaller part, for the mean maximum temperature, which increases as we pass farther into the narrow seas, is about 12° at the Shetland Islands, 14° at Newcastle and Bergen, 15.5° off Bohuslän, and 16.5° off Holland. Thus the one-time presence of the molluscs mentioned in Bohuslän seems especially to indicate that the winter temperature of the water was then higher and the temperature variations were less than at present. This is in accord with the fact that during the Tapes time the Gulf Stream, because of submergence of the northern end of Jylland, had freer access to the eastern Skagerack and touched the Swedish coast. Hence it seems probable that the water temperature in the Skagerack was highest during the climax of the submergence. To be sure, the late arrival of many south-ranging molluscs in Bohuslän suggests that the temperature was highest in sub-boreal time, in the Bronze age (HÄGG, 1924, p. 479), but the delayed immigration may be due to the fact that the dispersal required time.

The post-glacial maximum of the air temperature in northern Europe is now held to have been reached in Atlantic time (VON POST, 1924, p. 126). If this maximum implies higher summer temperature, other agencies may have cooperated with the Gulf Stream, for the influence of this current on northern Europe expresses itself largely in a decrease of the temperature variations, a considerable rise of the winter temperature, and a small lowering of the summer temperature (Schott, 1926, p. 264). The higher the temperature of the ocean, the more pronounced the low-pressure area between Iceland and Norway, the stronger and more constant the southwest-winds, and the milder the winters in Scandinavia; and the stronger the southwest-winds, the greater the quantities of warm surface water that are driven towards the northeast, and the warmer the winds and northern Europe.

VII. Changes of Level.

Changes of sea level.

During the climax of the last glaciation some 40 000 years ago the sea level probably stood about 90 m (300 feet) lower than today, the corresponding quantity of water being stored in ice (Antevs, 1926, 1928). As the ice melted, the sea level rose. During times of rapid melting and retreat of the ice edge, the rise was relatively rapid, though actually slow; during times of halt it was very slow or interrupted. Because of the vast extent of the oceans, fluctuations of sea level may ordinarily not have taken place during the halts and readvances of the ice border, oscillations occupying a few to several hundred years. An exception occurred perhaps during the great and long-continued oscillations in the uncovering of the Danish Islands and the probably corresponding southern Ontario and Quebec, i. e. during the period from 28 000 to 14 000 years ago. The glaciers may have been reduced to their modern volumes some 6 000 or 5 000 years ago.

A first rough attempt to illustrate the gradual rise of the sea from our knowledge of the waning of the ice sheets, etc. is made in Figure 1. Though not satisfactory, the curve helps to clear up certain aspects of the changes of level. The last part of the curve should be briefly considered.

From abandoned shore lines in many parts of the world Daly (1920; 1925, p. 293; 1926, pp. 174, 179; 1927, p. 80) concludes that the sea level a few thousand years ago stood about 5 m or 15 to 16 feet higher than today. Supporting evidence has been secured by Wentworth and Palmer (1925) and Ladd and Hoffmeister (1927), among others. Ramsay (1924, p. 16; 1926, p. 63) is inclined

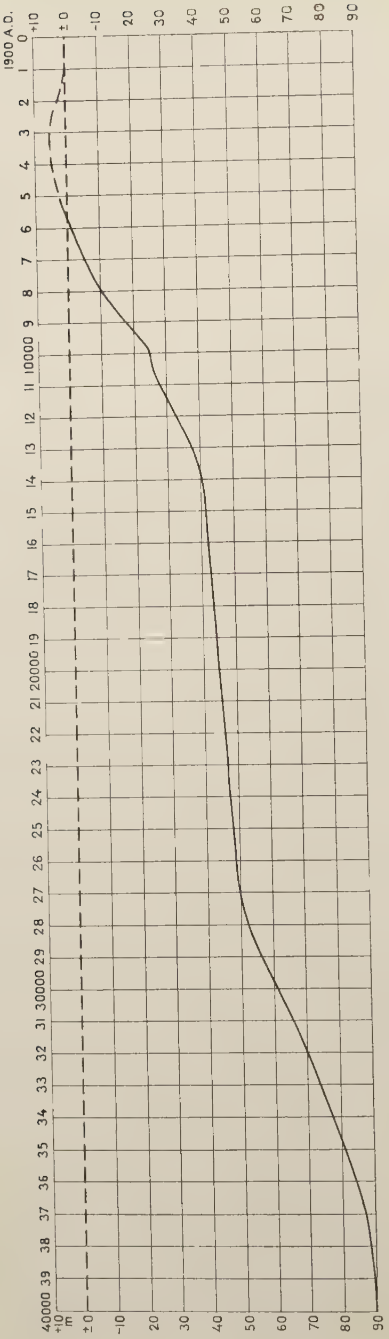

Fig. 1. Rise of sea level since the climax of the last glaciation.

to believe at least that the sea level has oscillated during the post-glacial age.

The high sea level is held by DALY to be due to shrinking of the ice sheets and glaciers to below their modern volumes on account of the higher temperature that prevailed from some 7 000 to 3 500 or 2 500 years ago. The subsequent sinking is believed to be due to a recrudescence of glaciation as the temperature fell. As nearly the whole fluctuations would be caused by variations in the quantity of the Antarctic ice, the conditions of nourishment of this ice sheet are of interest. It is, to be sure, held by several excellent authorities that a temperature rise would cause increase in the nourishment and expansion of this ice, but it nevertheless seems more probable that it would cause increase in the depletion (ANTEVS, 1928). Thus, a rise of the sea level during the post-glacial temperature maximum seems to be climatologically plausible.

A shift of the ocean level of 5 m is no small affair. The area of the ocean is about 361 059 200 sq. km. The area of the existing glaciers is about 15,700,000 sq. km, and that of the South Polar ice alone some 13,500,000 sq. km (HESS, 1904, p. 144; MECKING, 1925, p. 122). That is to say, the area of the ocean is about 23 and 27 times as large as the areas of all existing glaciers and of the Antarctic ice, respectively. Five meters of water on the oceans thus corresponds to 115 and 135 m of water over the areas of all glaciers and the Antarctic ice sheet, respectively. As most of the small glaciers are thin, probably some 125 m of water would have to come on the Antarctic ice. The specific gravity of ice being 0.916 (HESS, 1904, p. 13), such a water layer corresponds to an ice layer about 136 m thick. Thus a sea level 5 m higher may mean that the Antarctic ice was on the average 135 m thinner than today. As the ice sheet may have a mean thickness of some 1 525 m (5 000 feet) (DAVID, 1914, p. 613) or at least 1 000 m (MEINARDUS, 1925, p. 188), this is quite possible.

However, the alleged evidence of a higher sea level a few thousand years ago can be equally well explained by regional vertical movements of the earth's crust. A eustatic shift of sea level should be recorded by strand lines at the same level or levels only differing according to the nature of the shore line, the exposure, and the force and height of the breakers, and according to the changes in the earth's body caused by the removal of a large weight from the oceans to the Antarctic; but the highest or the only shore line, usually bench cut in rock, occurs at various levels between 6 and 3.5 m (20 and 12 feet) or perhaps still lower. On the Pacific coast of Canada there is evidence unfavorable to the view that the ocean level stood higher a few thousand years ago than at present (JOHNSTON, 1926). The region of the lower Fraser River has not appreciably changed its relationship to sea level for at least 5 000 and probably not for 8 000 years, which seems to be the age of the recent Fraser delta. There is no evidence on the coast of a post-glacial submergence, thought by DALY (1925, p. 293) to explain the absence of a recent lowering of the sea. However, there is a slight chance of a land sinking keeping even pace with the eventual lowering of the ocean level.

Because of this unsettled state of the problem two alternatives have been expressed in the curve. According to one, the sea level has been practically constant for some 5 000 or 6 000 years; according to the other, it was about 5 m higher than now a few thousand years ago.

Position of the shore line and vertical stand of the earth's crust in the North Sea area during the glaciation.

The isobase of zero of the late-Quaternary changes of level marks points which during the greatest transgression stood in the same relation to the then sea level at they now do to the modern ocean level. It does not indicate the boundary of uplift of the earth's crust. At the recording of the 0-isobase near Randers in Jylland the sea level and the region probably stood some 50 m lower than today. If the tilt of the earth's surface outside the 0-isobase was about the same as recorded by the marine limit inside this line, the regions of Varde, the Little Belt, and Stettin may have taken the same vertical stand as in our time, may have stood some 50 m above the then ocean level. Outside of here the land stood perhaps higher. During the maximum extent of the ice the earth's crust in these regions may have taken a lower stand, but there are no records of this.

In the British Isles records of a higher position of the strand line during the last glaciation are to be found only in Scotland (WRIGHT, 1914, pp. 365—370, 422). The submergence attained at most about 30.5 m (100 feet). On the Firth of Forth the 100-foot beach was recorded a long time after the maximum extent of the ice (GREGORY, 1926, p. 432). Also on the Firth of Clyde it was registered after the ice had begun to recede but still occupied the upper reaches of the highland lochs, as shown by its absence here

(Clough, etc. 1925, p. 215). The shore line, consequently, first reached its highest position after the sea level had risen an unknown amount. This seems to be due to a more rapid rise of sea level than of land. If the ocean level at the time stood some 50 m lower than now, Scotland stood some 80 m lower. The depression never reached 120 m, if the sea level, when lowest, receded 90 m. The southern and larger part of the British Isles was depressed less than 80 m, or lay as high as, or even higher than, today.

When Denmark was released from the ice, the southern part of the North Sea consequently seems to have stood actually as high as today, or even higher. The sea level at this time probably was some 50 m lower than at present. As the whole North Sea south of a line running from Scarboro northeastward to north of Skagen with the exception of small areas is less than 55 m (30 fathoms) deep, and the greater part of the English Channel east of Wight and Cherbourg is less than 50 m deep, the southern North Sea, the eastern half of the English Channel, the British Isles, and other areas may then have formed part of the European continent. At the climax of the glaciation, when sea level probably was some 90 m lower, land may have had still greater extent in these regions, though the vertical position of the earth's surface may have been lower.

Direct evidence of much lower stand of the shore line is furnished by submerged peat beds and forests occurring at intervals on the whole coast of England and Wales and from Denmark to France (Reid, 1913; Wright, 1914, p. 373; Kendall, 1917, p. 321; Wolff, 1921, p. 73; Simmons and Wray, 1923, p. 310; Dubois, 1924, p. 273; Mertz, 1924, p. 12). In southern England submerged forests are known down to about 18 m (60 feet) below sea level. There are commonly two peat beds separated by silts and clays containing fresh-water, brackish-water, or marine shells and indicating that considerable oscillations of level took place. The vegetable remains are of plants common in the British Isles and on the continental shores of the North Sea. The most common trees are *Betula alba* and *Alnus glutinosa;* but *Quercus robur* and *Betula nana* are occasionally met with.

On the Dogger Bank, which generally has a water depth of less than 25 m and over large areas of less than 20 m, peat beds have a wide distribution. On the slopes of the bank peat has been trawled from depths of 40 m; but it is not certain that this occurs in its original position. It might be derived from the top of the bank. The peat on the bank has a flora of a northern range.

It consists largely of herbs but also of a few trees and bushes such as *Betula alba*, *B. nana*, *Corylus avellana*, and *Salix repens*. The tree pollen flora of a sample was composed to 72 per cent of pine, 27.5 per cent of birch, and 0.5 per cent of elm and oak (ERDTMANN, 1925). This peat may date from the early boreal time or the transition from late-glacial to post-glacial time. The peat rests on clay crowded with shallow-water marine shells such as *Littorina rudis* and *Cardium edule*.

At an earlier period, bones of vertebrates were frequently obtained by fishermen from the floor of the North Sea. The remains include reindeer, mammoth, musk ox, hyena, and woolly rhinoceros. They may be, at least to a large extent, of other ages than the peat or moorlog.

In the Kiel Canal near the Elbe a forest bed with stools of willows has been met with at a depth of 20.5 m below sea level. And at Tönning peaty sand with fresh-water molluscs has been observed down to a depth of 23.6 m (WOLFF, 1921, p. 73).

The collected evidence seems to prove that larger or smaller parts of the southern North Sea and of the eastern Channel formed land from a time long before the climax of the last glaciation till the beginning of the post-glacial age. This is important for the understanding of the routes of immigration of the molluscs to the Scandinavian waters.

Changes of level in the Skagerack region.

Gothi-glacial uplift.

The highest late-Quaternary traces of the sea, the marine limit, lie at Göteborg at an altitude of some 95 m; southeast of Kungälv at 112 m; northwest of Lilla Edet at 130 m (MUNTHE, 1924, Pl. 3, pp. 106, 110; DE GEER, 1910 a); north of Uddevalla at 155 to 156 m (MUNTHE, 1924 b, p. 725); 10 km south-southwest of Dals Ed at about 170 m (DE GEER, 1909, p. 539); 20 km east of Strömstad at 165 m (DE GEER, 1910 a); at Mysen in Östfold at some 208 m (HOLTEDAHL, 1924, p. 108); at Oslo at 221 m (see REKSTAD, 1922); at Jessheim, Hauersæter, Dal, and Minnesund in Romerike at 208, 205, 200, and 191 m respectively (HOLTEDAHL, 1924, pp. 101—106; 1925).

The marine limit is not only of different ages in the different regions but was probably also registered by different oscillations of the strand line. At least in southern and central Bohuslän it

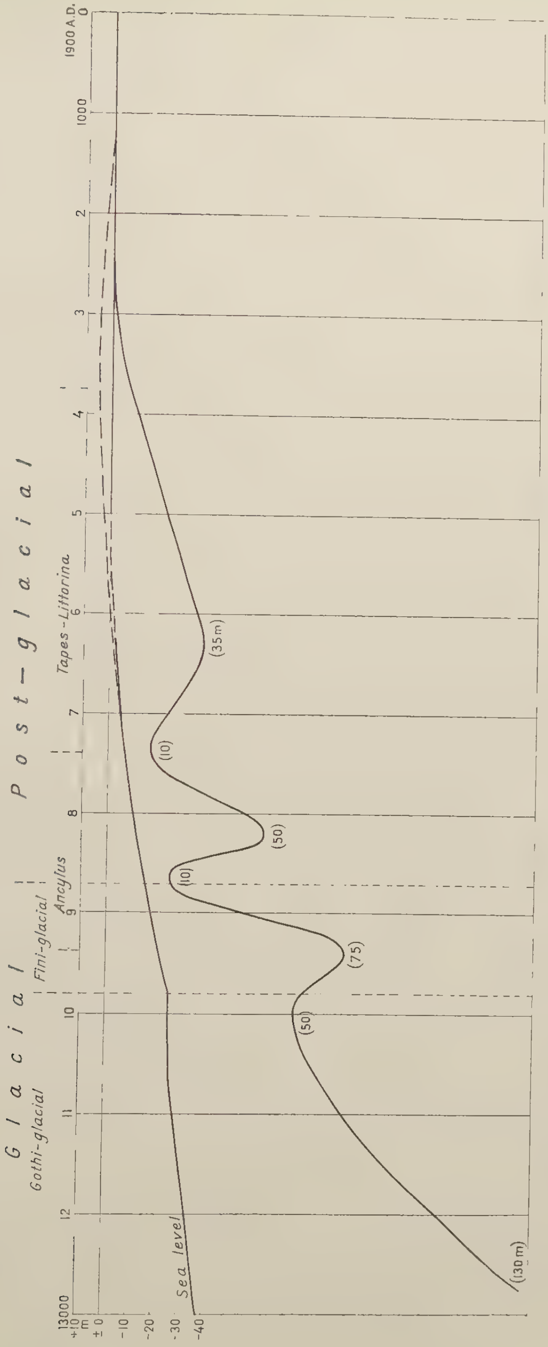

Fig. 2. The probable changes of level at Lysekil: Movements of a point lying on the modern shore line.

may date from the time of the release from the ice, for it seems to be marked by an outwash plain at Backamo northwest of Lilla Edet. The sea level at the time of recording was low but rising. When the marine limit was registered at Uddevalla some 12 000 years ago, the sea may have stood some 30 m lower than today, and the land consequently about (150 + 30) 180 m lower.

The first crustal movement may have been a rise, judging from arctic shell beds at low levels, especially those at Brandshult and in northernmost Jylland.

The shell bed at Brandshult, 24 km south of Göteborg and 2 km southeast of Särö, occurs 7 m above sea level and suggests a water temperature like that off western Kola today (BODMAN, 1916; our p. 546). As the highest rocks in the vicinity of the bed rise only 34 m above sea level, and as *Mytilus edulis* is one of the most numerously represented species, downwashing of shells cannot have played a great rôle; but when the bed was formed the shore in the region probably stood some 15 m above the present, may have stood at 20 per cent of the marine limit, which lies at 75 m. Whether the shore line was receding, as BODMAN thinks, or transgressing or stationary cannot be determined from the facts at hand.

The Kapellbacken beds, 1 km south of Uddevalla, which suggest a water temperature like that of today off the eastern Murman coast, extend down to about 10 m above the sea (DE GEER, 1910, Pl. 43, Table A; our p. 546). Adjacent rocks rise to several tens of meters, near the lowest bed to 53 m; and downwashing of shells evidently took place. However, the sandy and gravelly consistency of the material, the constant presence of the shallow-water form *Mytilus edulis*, and the occurrence of clay beds below and above the shell gravel seem to make it probable that the shell gravel was deposited in not too deep water and that the shore line withdrew to the level of 50 m or lower. However, ODHNER (1927, p. 109) thinks that all the beds at Uddevalla were laid down during the first uplift before the shore had receded to the level of 60 m.

In northernmost Jylland the following sequence of strata has been observed (A. JESSEN, 1899, pp. 214—223, 228; MERTZ, 1924, p. 10):

Topmost, shore gravel. Up to 27 m above the sea.
Sand, often strongly clayey, with whole shells — Zirphaea bed. Up to 25 m above sea level.
Shore gravel with worn fragments of shells. At 3 to 4 m above the sea.
Glacial clay.

The profile shows that the shore line receded from the marine limit, which at Frederikshavn lies at 58 m of altitude, to some 4 m above the present stand, was then displaced upward to the altitude of about 25 m, and finally withdrew. The fauna of the Zirphaea bed is composed of species occurring from the arctic regions southward, as *Astarte borealis*, *A. sulcata*, *Cyprina islandica*, *Macoma baltica*, *M. calcaria*, *Mytilus edulis*, *Saxicava arctica*, and *Zirphaea crispata* and of *Utriculus obtusus*, which has its northern limit at Vadsö. It thus suggests a water temperature like that now in Östfinnmark or off the western Murman Coast. It is low-arctic. The transgression, as pointed out by De Geer (1910, p. 1149), may thus be correlated with that recorded in the Kapellbacken beds. The first regression may consequently be identical with that suggested at Brandshult and Kapellbacken.

The changes of level in Southern Denmark should be briefly touched upon because of their great theoretical importance. The Öresund, at the release from the ice, had about the same relationship to sea level as today, for while Skåne stood relatively lower, Sjælland, possibly with the exception of the northernmost part, stood relatively higher (K. Jessen, 1923). The Öresund may consequently have been depressed some 50 m. However, it rose quickly, and the sill between Copenhagen and Malmö, which now reaches to within 7 m of sea level, may have been soon uplifted above the then ocean level. Channels of erosion near Copenhagen furnish direct evidence of an 18 m lower stand of the shore line (Milthers, 1922, p. 122). The southern Öresund stood high relative to sea level throughout the late-glacial and early post-glacial time, until the Tapes-Littorina submergence, as is shown by Knud Jessen's (1923; also Ramsay, 1924, p. 31) important study.

The Darsser Schwelle between Falster and Germany, whose lowest parts now reach to within 18 m of sea level, at the release from the ice may have stood actually slightly lower than today, though much higher, probably some 40 m, relative to sea level.

As the Baltic Ice Lake just before its drainage at Mt. Billingen was dammed up 25 m above the then sea level (p. 571), which probably stood about 25 m lower than the modern, the southern Öresund and the Darsser Schwelle then stood — 25 + 25 + 7 and — 25 + 25 + 18 m, i. e., respectively, 7 and 18 m actually higher than today, or rather not quite so high, since the outflowing water must have had some depth on the sills or at least on one of them. Thus, since the release from the ice the southern Öresund probably had risen at least some 50 m, and the Darsser Schwelle at least some 25 m.

The remarkably rapid and large rise of the earth's crust in this intermediate zone, in Falster, Sjælland, northern Jylland, and southern Sweden, is also well recorded at Kalmar. For, while the Baltic Ice Lake registered its shore at 75 to 80 m altitude (MUNTHE, 1910 a, Pl. 47), its level withdrew to below 11 m, while the climate in the region was arctic and the ice border not far distant (THOMASSON, 1927, pp. 69, 73).

Between the deposition of the Onsöy—Fredrikshall—Kornsjö—Hakantorp moraine and the Moss—Sarpsborg—Ed—Lidköping moraine, Dal, the region west of the southern part of Lake Vänern, rose more than 17 m, as shown by water-built outwash plains 10 km west-southwest of Ed and at Ed reaching levels of 170 and 152 m, respectively (RAMSAY, 1924, pp. 25, 26, 29; cf. DE GEER, 1909; 1910 a). And when the northern morainic line at Dals Ed was formed, the uplift had proceeded another 8 or 10 m, as indicated by the height of another wash plain at 143 m and a channel of erosion at 144 m in the southern outwash plain (RAMSAY). The total uplift in Dal during the formation of the morainic belt thus seems to have been more than 25 or 27 m. As the marine limit near Ed, according to DE GEER, lies at 169 m of altitude, and as the erosion channel at 144 m in the southern wash plain has a bed of clay which must be derived from the ice, transgression reaching above the shore line at the time of the uncovering may have set in when the ice border left the morains (RAMSAY). The shore line may in early fini-glacial time have been displaced from the level of 144 m to that of 169 m, or some 25 m. At Dals Ed, consequently, the land stood highest on the transition from the Gothiglacial to the fini-glacial ages.

The conditions at Karlsborg, on the western shore of Lake Vättern, so carefully studied by WESTERGÅRD (1926, pp. 54, 60—67), are of importance for this discussion, especially for the light they shed on the events at Mt. Billingen and the Danish Sounds. The Karlsborg region was rapidly rising during the uncovering, as shown by the northwardly decreasing interval between the Baltic limit and the marine limit. The former was recorded gradually by the Baltic Ice Lake; the latter was registered simultaneously upon the drainage of the ice lake. The rise is estimated by WESTERGÅRD at 7 to 8 m in 70 years, or at 11 cm a year. The upbuilding of the wash plains south of an east-westerly line at Humsjön, 10 km north-northwest of Karlsborg, to between 142 and 154 m with levels increasing toward the north, the occurrence of numerous distinct shore phenomena at the same altitudes, and the absence of indisputable traces of water work at higher levels prove that the Baltic Ice Lake at Karlsborg reached up to 153 m, not to 210 m as lately held by MUNTHE (1924 a, p. 175; 1925 a; 1926, p. 115). The wash plain at Humsjön, which is 2 km long and 1.5 km wide and has a generally even surface at 126 to 127 m altitude, and several other outwash plains and shore lines at the same level no doubt were formed in and by the sea after the drainage of the Baltic Ice Lake that took place as the ice border left the northern end of Mt. Billingen. They show that the lowering occurred from about 154 m to about 128 or 130 m and amounted to some 25 m. The absence of shore lines between the levels of 154 and 130 m shows that there was no later transgression above the shore line registered just upon the drainage. No transgression corresponding to that at Dals Ed, Uddevalla, and Skagen, took place (Cf. MUNTHE, 1928, p. 284).

At the northern end of Mt. Billingen the Baltic Ice Lake shortly before its drainage registered its level at 149 m altitude (LUNDQVIST, 1921). As the lowering amounted to 25 m, the sea at the time was at the level of 124 m. The bottom of the erosion channel cut in sandstone lies at 112 to 117 m (LUNDQVIST, 1921), thus 7 to 12 m below the then sea level, an amount agreeing fairly well with RAMSAY's (1924, p. 27) estimate. As the marine limit in the region lies at 132 m (LUNDQVIST, 1921; RAMSAY, 1924, p. 27), there was a subsequent fini-glacial transgression of at least 8 m. Whether the shore line retired below the 124-meter level before transgression set in is not known. Thus the exact time of the highest stand of the land is not known, but this may have about coincided with the drainage.

The position of the shore line in Östfold, the fylke east of the Oslofjorden, during the formation of the Dals Ed—Sarpsborg—Moss—Larvik moraine is not known from direct observations. The morainic line on the Norwegian side does not seem to exceed 140 m in height (HOLTEDAHL, 1924, p. 80). Judging from the conditions at Ed and Billingen the strand line probably stood a little below the marine limit which probably was recorded somewhat later. The subfossil molluscan fauna gives no indication of this. The colder faunas embedded in clay may have been contemporaneous with somewhat warmer bed-forming faunas on shallower water, as HOLTEDAHL (1924, p. 108) has already pointed out. The difference was due to habitat, to depth, not to time intervals. For instance, the Portlandia lenticula clay may be of the same age as the oldest shell beds. However, at Mysen, 50 km southeast of Oslo, the transgression reached its maximum — 208 m — at the release from the ice, as indicated by an enormous water-built wash plain (HOLTEDAHL, 1924, p. 108, 1925, p. 165).

Thus the marine limit, at least south of central Bohuslän, may have been recorded at the uncovering and at Ed, the northern end of Billingen, etc., during a later transgression. The Gothi-glacial regression seems to have proceeded until the shore line at Skagen, Brandshult, Uddevalla, and Dals Ed stood about 4, 15, 50(?), and 144 m, respectively, above the modern stand. The highest position may have been taken on the transition from Gothi-glacial to fini-glacial time, to judge from the conditions at Ed.

Fini-glacial sinking.

As intimated in the preceding pages the low stand of the shore line on the transition from Gothi-glacial to fini-glacial time seems to have been followed by transgression. At Dals Ed submergence appears to have set in as the ice border left the Fenno-Scandian moraines. It proceeded until the shore reached the level of 169 m, i. e. the marine limit, and amounted to 25 m. At the northern end of Mt. Billingen it also proceeded until the shore attained its highest stand, or 132 m. It was here only some 8 m. At Karlsborg no transgression occurred. In Östfold the amount of the eventual transgression is unknown.

A fini-glacial transgression is perhaps also recorded by the shell beds at Kapellbacken (cf. p. 547). In all the beds examined by DE GEER (1910, Table A) except F42 *Mytilus edulis* decreases in numbers upwards. The shell gravel is furthermore sandy and overlain by clay. This clay, however, lacks fossils and is observed at heights of from 24 to 50 m (DE GEER, 1910, p. 1167), so that it is not necessarily of fini-glacial age. It deserves mention that at Marieberg, just north of Uddevalla, a clay with arctic shells has been observed resting on a late-glacial shell bed (see DE GEER, 1910, p. 1148). Finally transgression is suggested by the occurrence at higher levels in other parts of Bohuslän of beds with somewhat warmer faunas than some of the Kapellbacken beds. In opposition to this view ODHNER (1927, p. 108) thinks, in agreement with SANDEGREN, that the Kapellbacken beds give no clue as regards the changes of level, as they probably were formed of downwashed shells, and the most important species in the bed C 16 do not show any regular variation in frequency.

The level to which the shore line may have transgressed in central Bohuslän is not definitely known. At Kapellbacken fini-glacial beds occur from 10 to 75 m of altitude; and 75 m is regarded by De Geer (1910, p. 1168) as the minimum height. However, as near Stale, some 10 km northwest of Uddevalla, a shell deposit containing, besides high-arctic species, also *Littorina littorea*, *Macoma baltica*, and *Mytilus edulis* occurs at an altitude of 102 m, or 60 to 65 per cent of the marine limit, and as marked beaches are to be found in the vicinity at the height of 110 m, the level of 110 m is thought eventually to mark the limit of transgression (De Geer, 1910, p. 1170). Since in the region of Göteborg *Mytilus edulis*, *Macoma baltica*, and *Littorina littorea* have been found at 80, 72, and 64 per cent of the marine limit, respectively, and thus immigrated very early (Munthe, 1924, p. 129; also Hägg, 1924, p. 474), the former alternative seems most probable. The sinking may thus have amounted to some 25 m (Fig. 2, p. 567).

At Skagen the transgression may have been from about 4 to about 25 m above sea level.

The limitation of the Zirphaea beds to the region north ot Frederikshavn suggests that the southern limit of the oscillation lies in northern Jylland and that it consequently affected the belt between Karlsborg and the Limfjorden. Because of the actually very slow rise of the sea level in spite of the rapid melting of the ice in fini-glacial time, the transgression may have beeen mainly caused by land sinking.

Fini-glacial uplift.

The fini-glacial sinking was but a zonal interruption in the large upheaval. Soon afterward uplift again prevailed, surpassing the slow rise of the sea. In central Bohuslän the shell beds as regards composition form a complete series from the Sparöd bed at 66 m altitude down to the Tången bed at the modern sea level. As this latter, as well as the beds Hermanö at sea level and Morlanda 5 m above the sea, was formed in the strand line or in very shallow water, the shore in the Hermanö-Mollösund region may have retired at least down to the present stand.

In northern Halland, at 7 km southwest of Kungsbacka and 5 km east of Varberg, peat beds with pine, birch, and hazel occur between marine deposits, at the heigth of some 10 meters, showing that the shore in early Ancylus time receded to and probably below this level (Halden, 1922, pp. 6, 25, 30). At Skagen the strand line withdrew to its present stand or lower (Mertz, 1924,

p. 12). At the southern end of Norway it receded below its modern position, as testified by peat bogs with *Betula nana* on the sea bottom off Lister (SHETELIG, 1920, pp. 30, 31).

The regression was perhaps soon interrupted by a halt or transgression, for at Mt. Billingen a marked beach is to be found at 118 m of height, i. e. 14 m below the marine and fini-glacial limit (LUNDQVIST, 1921), and at Karlsborg a distinct strand line occurs at about 114 m, or also 14 m below the marine limit (WESTRRGÅRD, 1926, p. 68).

In southeastern Norway the rise may have been very rapid, especially during the uncovering of the region between Oslo and Lake Mjösa, for the marine limit sinks in this distance from 221 to 191 m, which is an unusual phenomenon (see p. 566). Some of the shell beds in Aremark between 150 and 124 m altitude, viz. Kilebråten (p. 583), Kilebu and Kilebutangen (ÖYEN, 1908, p. 96), Kolbjörnsvik (ÖYEN, 1908, p. 93), and Kilen (p. 585), have a maximum of *Mytilus* at or near the bottom and possibly indicate one or more oscillations of the shore line. However, the frequency variations may be due to changes in local conditions unrelated to depth. More weighty is the following section measured by BJÖRLYKKE (1914, p. 24) at Ås, 25 km south of Oslo:

Topmost, 2— 4 dm gravel.
9—10 dm marine clay with fossils.
2— 4 dm gravel very rich in shells including *Pholas candida* and *Zirphaea crispata.*
18—19 dm stratified marine clay with *Arca glacialis*, *Portlandia lenticula*, etc.
Till.

The intercalated shelly gravel is thought to have been formed in shallow water when the shore stood at 130 m altitude, and the upper clay during a subsequent transgression.

In Östfold the shore line may have finally receded to about 50 per cent of the marine limit, to 85 to 110 m above the modern stand.

In När, in southeastern Gotland, a gravel bed occurs upon glacial clay and beneath Ancylus sediments 2 m above sea level. Off the coast of Gotland gravel, which is held by MUNTHE to be shore gravel, occurs out to depths of some 20 m. The immigration of plants and animals to Gotland as early as to southern Sweden suggests that at most a narrow water separated the island from Germany and southeastern Sweden. Thus, the shore in southern Gotland, according to MUNTHE (1910; 1925, pp. 47, 51, Pl. 7), in late-glacial time and early Anculus time stood at least as low as today and probably much lower.

Ancylus sinking.

While the shell beds at Morlanda, Hermanö, Tången, etc., at and near the modern sea level indicate a water temperature such as now prevails off Vestfinnmark and Lofoten, the beds at Bredhult, Skärjedalen, and Skärje at 71, 63, and 60 m height, respectively, suggest a water temperature like that in the Trondhjemsfjorden (p. 549). These latter beds consequently indicate a later submergence or land sinking. The water temperature indicated by the last-mentioned beds still being relatively low, and the altitudes of the beds being much greater than that of the Tapes limit, the sinking must have been of early post-glacial age, of Ancylus age. The Bredhult, Skärjedalen, and Skärje beds may date from the rise following upon the greatest transgression, but the Gudebo bed at 48 m seems by its composition to mark transgression.

As Hermanö, Morlanda, and Tången lie some 10 to 20 km south of Lysekil, and Bredhult, Skärjedalen, and Skärje lie far north of Strömstad, the difference in altitude between them does not give any measure of the oscillation. The actual limit of transgression is not surely fixed anywhere, but in northernmost Bohuslän it must lie above the Bredhult bed whose height was determined by De Geer, probably by means of a small angle instrument, at 71 m. At Skärjedalen, 2.5 km north of Bredhult, the limit should lie slightly higher. The cobble field just above this bed, or at 66 m as determined by Hägg (1924, p. 477) by means of a spirit level, might possibly mark the limit. In central Bohuslän the rising shore line may have passed the levels of the beds Stångenäs and Kapellbacken L 46, i. e. the 50-meter level. Just northeast of Gräbbestad the limit is perhaps recorded by a cobble field between 46 and 56.5 m high observed by Hägg (1924, p. 477).

In northern Halland the shore line transgressed more than 10 m, or from some 10 to 20 m above sea level, contemporaneously with the Ancylus transgression within the Baltic (Halden, 1922, p. 30).

In Östfold and at Oslo, at about 50 per cent of the marine limit, Portlandia lenticula clay has at places been observed on the top of Mytilus deposits (Brögger, 1901, pp. 638—645, 714; Björlykke, 1913, pp. 72, 81, 92). In a few cases this stratification is known to be due to downsliding of the Portlandia clay, but in one or two instances the stratification might be original and indicate a small oscillation of the shore line.

An outlet channel south of Degerfors in Närke, east of Lake Vänern, of the Baltic during the Ancylus stage shows that the then Baltic really was isolated from the sea and formed a lake (MUNTHE, 1924 a, p. 176; 1928 a). The threshold of the outlet is situated at 105 to 110 m altitude. During its climax, at the drying up of the outlet in Närke, Ancylus Lake stood about 32 m above the contemporaneous sea (VON POST, 1928, pp. 100, 119).

Ancylus Lake came into existence as the previous sounds across central Sweden disappeared because of the uplift of the land. Its level was determined by the threshold south of Degerfors. As this rose, the lake level rose and transgressed over regions that were not rising at the same rapid rate. As the rate of the uplift may have increased from the outlet channel northward no transgression may have taken place north of it. Here the rise of Ancylus Lake only caused a slowing down of the regression of the strand line. The Ancylus transgression may be limited to the region south of the outlet. Sinking of the outlet would have caused regression of the shore of Ancylus Lake.

At the outlet the level of Ancylus Lake rose 32 m + some 8 m, the latter figure being the probable contemporaneous rise of the ocean level. Where the land rose, the transgression was less than 40 m; where it eventually sank, it was greater than 40 m, and vice versa. The Ancylus transgression is recorded in many places in southern Sweden. Thus, at the northern end of Lake Vättern, at Karlsborg, and at several places farther south the Ancylus beach is underlain by peat and in Gotland besides by organic lake sediments (MUNTHE, 1926, p. 112; 1925, pp. 51, 76, Pl. 7; WESTERGÅRD, 1926, p. 69).

In southern Gotland the shore previous to the Ancylus transgression may have stood at least as low as today and probably much lower (p. 574). As the Ancylus beach in När lies at 24 m of height, the Ancylus transgression here amounted to more than 20 m. From this and the fact that the transgression caused by the rise of the lake level amounted to at most 40 m it follows that southern Gotland can have risen at most some 15 meters during the Ancylus transgression. If the shore in early Ancylus time stood 20 m lower than today, as MUNTHE considers likely, the subsequent transgression to 24 m above sea level is not accounted for by the rise of the lake level alone. Then a bending down of the earth's crust must have taken place. If the shore at När had receded to the level of -20 m the bending down here was $20 + 24 - 40 = 4$ m. Thus, the Ancylus sinking eventually affected Gotland.

The damming up of Ancylus Lake 32 m above the then sea level shows that the southern Öresund stood at least $-10 + 7 + 32 = 29$ m and the Darsser Schwelle $-10 + 18 + 32 \quad 40$ m higher than today, i. e. as far as known higher than at any other time. The figures 10 indicate the probable lower stand of the then sea level, and the figures 7 and 18 give the modern water depths on the thresholds. From these latter it follows that the shore line in the southern Baltic then lay more than 18 m lower than at present. The occurrence of stools of pine trees in original position at a water depth of 35 to 37 m 13 km off Kåseberga, or 24 km southeast of Ystad, suggests that the strand line actually stood below the depth curve of 40 m and that the greater part of the southwestern Baltic formed land (ISBERG, 1927). Peat obtained from a hollow stump contained pollens of pine, spruce, alder, oak, linden, elm, hazel, and willow suggesting late boreal age. If this low position of the shore line was taken when Ancylus Lake stood 32 m above the then sea level, and if this latter stood 10 m lower than the modern sea level the region southern Skåne—Bornholm lay as much as $40 + 32 - 10 = 62$ m higher than today. No indication of an eventual oscillation of level is known in the southern Baltic. (Also GRÖNWALL 1927; MUNTHE 1928 a, p. 101.)

Late Ancylus uplift.

Like the fini-glacial transgression the Ancylus transgression was only a subordinate interruption in the uplift limited to the intermediate belt of the glaciated area. The rise was thus resumed.

Beds which, judging from their composition, their presentation of low-boreal molluscs in subordinate numbers, may be derived from this uplift are found in central and southern Bohuslän down nearly to the modern shore. At Fjällbacka the strand line seems to have receded to some 17 or 20 m above the modern stand, as the s-forms in a bed reach maximum at a level of 16 to 18 m and as another shallow water deposit is to be found at only 10 m of altitude (ANTEVS, 1917, p. 278; this paper pp. 534, 611). At Bovallstrand and Gravarne it may have retired towards the 10-meter level, if the beds Ellene and Näset I are correctly dated and interpreted (p. 613). At Mollösund it probably withdrew to below the level of 10 m, as suggested by the bed Tången II at 2 m above the sea (p. 598). In the skerry guard off Göteborg the shore line may have receded down towards the 5-meter level, judging from the Sörgården bed at 2 m height (p. 612).

At Änggården, just south of Göteborg, the events are illustrated by the following interesting section observed by SANDEGREN (1924, p. 146):

Topmost, 1.4 m post-glacial marine clay.
0.25 m somewhat gravelly sand.
0.25 m peat.
18 m clay.
2 m till?
Bed rock.

The surface lies at 17.6 m height. The lower clay is leached to a depth of 1 or 2 dm, i. e. to the level of 15.5 m above the sea. The shore line evidently withdrew to below 15.5 m and then transgressed. The time of the lowest stand is found by SANDEGREN in a study of the tree pollen to be just before the age of mixed oak forests, i. e. just before the beginning of the Tapes-Littorina transgression.

In northern Denmark no records of the events during this time are known, but uplift may have taken place.

All regions equally as central or more central than Bohuslän underwent a considerable uplift. In the Oslo region the shore line receded to the level of some 67 or 70 m (BRÖGGER, 1905, pp. 97, 305; BJÖRLYKKE, 1913, p. 161).

In southeastern Gotland the shore line withdrew to its present stand or nearly as far, as is shown by a cobbly sand from late Ancylus time at 5 m altitude in När (MUNTHE, 1925, pp. 51, 76, Pl. 7). The regression was largely brought about by lowering of the Baltic caused by the sinking of the Darsser Schwelle and the southern Öresund which put an end to the Ancylus transgression. As the lowering of the Baltic to the sea was some 15 m, the sea level having in the mean time risen about 5 m, the regression of 20 m in addition postulates an uplift of the land of 5 m.

Tapes-Littorina sinking.

Again the regression was interrupted by transgression as shown by warmer and younger shell beds at higher levels, marine beds on top of peat, etc. The shore line was removed from the limit of regression in the late Ancylus and early Littorina age up to the limit of transgression in the middle Tapes age.

If the previous limit of regression is correctly determined (see p. 577), the transgression in the region between Göteborg and Fjällbacka amounted to some 20 m.

The Tapes limit according to SANDEGREN (1924, p. 150) lies 40 m above sea level at Ljung and Hjärtum, 35 m at Lysekil and 6 km south of Lilla Edet, 30 m 5 km north of Kungälv, 25 m just south of Göteborg, and 20 m at Kungsbacka. At Änggården, just south of Göteborg, the shore moved from below the level of 15.5 m up to that of 25.5 m, i. e. more than 10 m (see p. 578).

The transgression affected the southwestern part of Lake Vänern (JOHAN ALIN, see VON POST, 1925, p. 441), but its northern limit is not known. The stratigraphy of one or two deposits at Oslo. thought by ÖYEN (1905, pp. 9—11) to prove a sinking from 67 to 70 m, and a sand layer at low levels in the clays at Drammen noted by BRÖGGER (1905. pp. 97—99, 305; 1901, pp. 477, 636), are not convincing evidence that it extended so far north. However, shell deposits with *Tapes decussatus* are known up to 70 m of altitude at Oslo and 40 m in Hvaler at the mouth of the Oslofjorden.

In När, southeastern Gotland, the shore transgressed from below the level of 5 m up to that of 16 m (MUNTHE, 1925, p. 51. Pl. 6).

The Tapes-Littorina transgression in southern Sweden and in Denmark seems largely to be part of the lowering that in late Ancylus time and early Littorina time affected the superelevated outer belt of the glaciated area. It was only to a lesser extent due to rise of the sea level (see p. 567). This superelevation is held by DALY (1925, p. 303; 1926, pp. 198, 200) to be due to an elastic rise of the earth's crust following upon the unloading of the ice, and the subsequent sinking thought to be due to breaking down of the rigidity of the earth's shell. The unraised part affected seems to have been pulled along because of the rigidity of the earth's crust. The southern Öresund, at the climax of the Ancylus transgression, stood at least 17 m and perhaps 50 m higher than today (see p. 577). It sank and during the Tapes transgression lay 3.5 m lower than at present (MERTZ, 1924). The Darsser Schwelle at the same time sank 28 m, or perhaps more than 50 m, down to its modern stand. This lowering, begun at the Öresund and the Darsser Schwelle at the climax of the Ancylus transgression and causing the regression of Ancylus Lake, spread gradually. Its amount decreased from the center of the bulge, the exact location of which is not known. It decreased from some 28 m, or more than 50 m, on the Darsser Schwelle to zero in northern Bohuslän or in Östfold. In northeastern Denmark the sinking proceeded until the Old Stone age, in southwestern Denmark till the Bronze age, when uplift set in (MERTZ, 1924, p. 16). The so-called outer limit of the Tapes-Littorina transgression may thus in reality be the distal boundary of land that has undergone uplift after the sinking mentioned.

Tapes-Littorina uplift, second Littorina transgression, and post-Littorina uplift.

The Tapes-Littorina sinking was followed by upheaval. In Bohuslän only records of uplift seem to be known after the Tapes sinking, but in southern Norway and in the Baltic geological and archeological indications of still another transgression have been produced (see SHETELIG, 1920, p. 39; RAMSAY, 1926, pp. 31, 61). The transgression took place towards the end of the Stone age, i. e. somewhat more than 4 000 years ago, when the shore line stood at 50 to 65 per cent of the Tapes-Littorina limit. It was perhaps largely caused by a higher stand of sea level than at present. Then regression again proceeded. At the beginning of the Bronze age, some 3 500 years ago, the shore line in Gotland may have stood only some two meters higher than today (MUNTHE, 1925, p. 76). At the end of the Bronze age, or about 2 500 years ago, the strand line on the Oslofjorden may have lain but a few meters above the present (see WITTING, 1918, p. 317). Bohuslän has perhaps risen at the modern rate, which is 4 mm a year, since the age of Passage Graves roughly 4 500 years ago (WITTING, 1918, pp. 274, 318). That is, it has perhaps risen some 18 m. But the shore line may rather have already taken its present stand during the latter part of the Bronze age about 2 700 years ago (FRÖDIN, 1906, p. 33).

VIII. Description of Raised Shell Beds.

Late-glacial beds.

Beds from the Gothi-glacial uplift.

Noleröd.

Table p. 646.

13 km WNW of Göteborg, 1.3 km SW of Torslanda Church, probably about 30 m above sea level, 1917.

The bed is situated on a level rock plateau. It has had an extent of several tens of square meters, but is now largely removed.

Only one sample was taken. The shell gravel is fairly stony. Part of the *Saxicava* shells are as large as they become in the Arctics.

The composition of the fauna, 8 ax-forms and 4 a^{1}x-forms, suggests conditions like those on the Murman Coast or in the White Sea, where *Anomia ephippium* reaches its northern limit of distribution.

The occurrence on a level plateau excludes the possibility of the shells having been washed down or up. The presence of both a d-form as *Pecten islandicus*, not recorded from water shallower than 9 m, and s-forms as *Littorina* and *Mytilus* suggests that the bed was laid down when the water level stood from about 15 to a few meters above it. The single sample analyzed, of course, gives no indication regarding the changes of level during the time of formation.

The bed occurs at about 40 per cent of the marine limit and was formed when the shore line stood at about 50 per cent of the limit mentioned.

Önna.

Table p. 646.

4 km E of Hunnebostrand, 1 km SSW of Tossene Church, 50 m W of the highway, about 59 m above the sea, 1917.

The shell bed occurs in the innermost part of an angle between rock walls to the north and west. The northern rock wall rises perpendicularly 15 to 20 m above the bed, the western wall some 5 m. The bed rests against the walls and slopes toward the east and south, where the land is open and plain. It is 1 m thick and underlain by till. The material is somewhat clayey and stony. It consists quite predominently of *Balanus porcatus.* The fauna contains 5 ax-forms and 1 a^{1}x-form, *Mytilus edulis*, which is dispersed up to the western coast of Novaya Zemlya. The shells of *Balanus porcatus* and *Saxicava* are large and thick. Of the species 1, *Mytilus*, is s-form, 3 are sd-forms, and 2, viz. *Balanus porcatus* and *Pecten islandicus*, are d-forms. *Mytilus* may have been washed down from rocks; and the bed was probably formed at a depth of some 10 m. The formation may have taken place shortly after the uncovering from the ice.

Tossene.

Table p. 646.

200 m NE of the preceding bed, about 46 m above sea level, 1917.

The shell bed occurs near the end of a pass. It is cut through by the highway. In the south the ground is level, in the north the pass enters a large and much lower valley. The rocks bordering the glen rise 15 to 20 m above the shell bed. This is large and at places certainly a few meters thick. Now it is largely removed. Where the samples were taken, at a depth of 1 m, and at the surface the bottom was not reached. The lower sample is a clay rich in shells. The percentage of clay decreases upward, and the upper sample is a slightly clayey shell gravel. The percentage of pebbles is small and increases somewhat upward.

The fauna is composed of 10 ax-forms and 1 a¹x-form — *Mytilus edulis*. *Saxicava* and *Balanus porcatus* are represented by large and thick shells. The temperature of the water may have been about that of the eastern Barents Sea today.

In regard to the depth at which the molluscs preferably live, the composition is 1 s-form, 3 sd-forms, and 7 d-forms. The dominating species are the sd-forms *Saxicava* and *Balanus crenatus*. The s-form *Mytilus* only occurs in the top sample. This fact, together with the upward decrease of the clay, etc., makes it probable that the bed was deposited during regression. The depth of deposition may have been 10 m or less.

Tumlehed.

Table p. 646.

14.5 km WNW of Göteborg, 2.3 km W of Torslanda Church, 200 yards S of Tumlehed Farm, probably about 20 m above sea level, 1917.

The shell bed is situated in a small glen, the rocks rising 6 to 8 m above the surface of the deposit. It is fairly large and more than 1.3 m thick. The substratum was not reached. Samples were taken at a depth of 1.3 m and at the surface. The lower sample is somewat stony, the upper one fairly stony.

The fauna is low-arctic, of the composition 8 ax-forms and 3 a¹x-forms. The coldest species, *Modiolaria corrugata*, has its southern limit at Hammerfest. The warmest species, *Verruca* and *Macoma baltica*, range up to East Murman and Spitsbergen and to Kolguev Island, respectively. *Saxicava* and *Balanus porcatus* are represented by partly large shells.

The fauna is largely composed of species living from the water line down to great depths. However, *Pecten islandicus*, represented by fragments, is not known to live in water less than 9 m deep;

and *Mytilus*, also poorly represented, prefers quite shallow water. The former may have been washed up, or the latter may have lived on the adjacent rocks. All things considered, the bed probably was formed when the water level stood some 5 to 10 m above it. Whether the deposition took place during decrease or increase of the water depth cannot be said. The bed occurs at some 25 per cent of the marine limit.

Beds from the fini-glacial uplift.

Moen.

Table p. 646.

14 km ENE of Fredrikshall, 3.5 km due N of the locks at Krappeto, on the highway just S of Moen, 1917. Altitude about 139 m according to ÖYEN (1908, p. 71).

The shell bed occurs on level ground. It has been large but in 1917 was largely removed. It is 2.25 m thick, underlain by pure sand, and overlain by a layer of shell-free sand 2 dm thick. Samples were taken at bottom, 0.75 and 1.5 m above bottom, and at top. The material contains few pebbles but a good deal of sand. The shells of *Saxicava* and *Balanus* are small and medium-sized. The bed contains numerous pockets of sand extending down from the surface, probably due, as various writers have pointed out, to dissolution of shells (see HALDEN, 1925 a). A number of species are mentioned by ÖYEN though not found in our samples, viz.: *Anomia ephippium*, *Buccinum undatum*, *Cyprina islandica*, *Littorina littorea*, *Macoma calcaria*, *Mytilus modiolus*, *Natica affinis*, and *Tectura rubella*. Besides these, *Trophon clathratus* is recorded by BRÖGGER (1901, p. 260).

The fauna consists of 8 ax-forms and 8 a^{1}x-forms, and suggests a water temperature like that off eastern Kola at the present time. Bathymetrically it is divided on 4 s-forms, 7 sd-forms, and 5 d-forms. *Balanus crenatus* predominates. The frequency of the different species changes little in the bed. This may have been deposited in water less than 10 m deep.

Kilebråten.

Table p. 646.

24.5 km NNE of Fredrikshall, 8.5 km NNW of Aremark Church, 1 km W of Kilesjöen, 0.5 km S of Bråtene Farm, 1917. Altitude about 150 m according to ÖYEN (1908, p. 86).

The bed occurs on level ground. No elevations occur in the vicinity. The deposit has very wide extent and locally doubtless great thickness. At the examined exposure the thickness was 1 m, and the substratum bed rock. Samples were taken at bottom, middle, and top. The material contains little mineral matter but a fairly high percentage of fragments of *Balanus crenatus* and *Mytilus edulis*. *Mytilus modiolus*, *Natica affinis*, *Pecten islandicus*, and *Trophon clathratus* are recorded by Öyen, though not found in our samples.

The fauna is composed of 9 ax-forms and 8 a^1x-forms, and bathymetrically of 4 s-forms, 7 sd-forms, and 6 d-forms. It is comparable to modern faunas on the coast of eastern Kola. *Balanus crenatus* predominates, *Mytilus edulis* is fairly well represented, and *Saxicava* is poorly represented, while the others are represented by single individuals. In the section studied by the writer the frequency of *Mytilus edulis* undergoes but little change. But in a section, 2 m high, studied by Öyen, *Mytilus* dominated entirely at the bottom, decreased to one-fourth of the material in the middle, and again increased to one-half at the top. The material for the rest consisted largely of *Balanus crenatus*. This variation of *Mytilus* perhaps suggests deposition during transgression and subsequent regression, and possibly indicates an oscillation of the shore line (p. 574).

Krappetolien.

Table p. 646.

12.5 km NNE of Fredrikshall, S of the Stenselva, on the road a few hundred meters S of the locks at Krappeto, 1917. Altitude about 136 m according to Öyen (1908, p. 70).

The bed occurs on a northward slope in a mossy spruce forest. Its extent can therefore not be determined, but this may be rather large. In an examined section the thickness was 1 m. The substratum is clay. The bed is massive, without distinct stratification. Samples were taken at bottom and at top. The mineral content is small, the bulk of the material consisting of shells and fragments of *Balanus crenatus*. In addition to species found in the samples here published, the following are recorded by Öyen: *Astarte montagui*, *Balanus porcatus*, *Buccinum undatum*, *Macoma baltica*, *Pecten islandicus*, and *Zirphaea crispata*. The fauna resembles modern faunas on the coast of eastern Kola Peninsula. Bathymetrically it is composed of 4 s-forms, 6 sd-forms, and

7 d-forms. Downwashing may have taken place rather than upwashing, and the bed may have been largely formed at a water depth of several meters.

Åsgård.

Table p. 647.

16 km ENE of Fredrikshall, 8 km SSW of Aremark Church, 2.5 km NW of Lake Asperen, 300 m NNW of Åsgård, 1917. Altitude about 122 m according to REKSTAD (1922, p. 21).

The bed occurs on the slope of a hill some 2 m high. Other elevations are lacking in the vicinity. The deposit is 0.5 m thick and rests on clay. The material is fairly stony and sandy but not clayey. The shells are small and medium-sized.

The fauna is composed of 4 ax-forms and 3 a^1x-forms. The latter are *Mytilus edulis*, *Macoma baltica*, and *Verruca*, now dispersed up to Novaya Zemlya, Kolguev Island, and the entrance to the White Sea, respectively. *Macoma* and *Verruca* are barely represented. The bed consists almost entirely of *Balanus crenatus* and *Saxicava*. The temperature of the water may have been like that of the sea off eastern Kola at the present time.

In regard to the bathymetrical distribution of the animals, the fauna is composed of 2 s-forms, 4 sd-forms, and 1 d-form. The bed may have been essentially deposited when the sea level stood some meters above it.

Kilen.

Table p. 647.

24 km NE of Fredrikshall, 7 km NNW of Aremark Church, on the west side of Kilesjöen, on the road just S of Kilen, 1917. Altitude about 124 m above sea level according to ÖYEN (1908, p. 84).

The bed occurs between two rocky ridges that run about 40 m apart and rise at most some 2 m above the deposits. Other elevations are lacking. The bed is rather large and 0.8 m thick. It rests on clay about 0.2 m thick. Below the clay is bed rock. Samples were taken at bottom and top. The material contains little mineral matter, but there is a large percentage of fragments of *Mytilus* in the lower part and of *Mytilus* and *Balanus* in the upper part. The following molluscs, not found in the writer's samples, are recorded by ÖYEN: *Astarte montagui*, *Macoma calcaria*, and *Trophon clathratus*.

The fauna is thus composed of 11 ax-forms and 4 a^1x-forms. It suggests a water temperature like that off eastern Kola today.

Bathymetrically it is composed of 2 s-forms, 7 sd-forms, and 6 d-forms. Neither upwashing nor downwashing of shells has taken place. Probably at least some of the d-forms lived on the spot while the water was fairly deep.

The predominance of *Mytilus* at bottom might indicate an oscillation of the shore line (p. 574).

Hagtorn.

Table p. 647.

13 km ENE of Fredrikshall, on the northern side of the Stenselva, 200 m E of the locks at Krappeto, 1917. Altitude about 110 m according to Öyen (1908, p. 65).

The bed is situated close to the river, between a steep rock wall, 20 m high, in the north and a low rocky knob in the south. It is 0.5 m thick and of similar consistency throughout. It is covered by a thin layer of mold. The material consists almost entirely of *Mytilus edulis*, especially of fragments of this species. It contains scattered pebbles and some fine sand. In the section observed by Öyen a layer with *Mytilus modiolus* occurred beneath that with *Mytilus edulis*. Besides the forms encountered in the statistic sample a number are recorded by Öyen, viz.: *Anomia ephippium*, *Astarte montagui*, *Buccinum groenlandicum*, *B. undatum*. *Lepeta coeca*, *Macoma calcaria*, *Margarita groenlandica*, *Mya truncata*, *Mytilus modiolus*, *Natica affinis*, *Pecten islandicus*, *Puncturella noachina*, and *Trophon clathratus*. A fragmentary shell attributed by Öyen to *Kellia lactea*, though the hinge is not typical, had better be disregarded, as this mollusc reaches its northern limit in the Öksfjorden in Vestfinnmark.

The fauna thus comprises 15 ax-forms and 8 a^{1}x-forms. The most southerly species are *Gibbula tumida* and *Tectura virginea*, which are now dispersed up to the Murman Coast. As regards the depths preferred by the molluscs it consists of 3 s-forms, 8 sd-forms, and 12 d-forms. Besides the dominating *Mytilus edulis*, *Balanus crenatus* is numerous and *Saxicava* is fairly well represented. *Lepeta coeca* and *Pecten islandicus* are not recorded from less depth of water than 9 m and perhaps did not live together with *Mytilus edulis*. Upwashing of shells may not, for topographic reasons, have taken place in this instance; but *Mytilus* may have lived on the rocks when the water level stood high above the bed; or — and this is perhaps more probable — the d-shells may have been deposited when the water level stood several meters above the place, and *Mytilus* and others later, when the receding shore line passed.

Lindal.

Table p. 647.

11 km ENE of Fredrikshall, on the northern side of the Stenselva, 0.8 km E of the locks at Brekke, 1917. The bed occurs 4 m above the river, which stands 7 m above Femsjöen whose level is at 82 m altitude. The bed thus lies about 93 m above sea level. It is described by BRÖGGER (1901, p. 267) and ÖYEN (1908, p. 53).

The bed occurs in the river valley at the foot of rock ledges that rise steeply some 10 m above it. In 1917 it was largely removed and much slumped. Three samples were taken with a vertical distance of 1 m between each. The lowest sample contains considerable mineral gravel and sand, the other two contain some. None contains clay. The finer fractions of the two upper samples consist essentially of shell fragments. The shells of *Saxicava* and *Balanus* are small and medium-sized. Besides the species encountered in the samples analyzed by the writer, the following are recorded by ÖYEN: *Anomia aculeata*, *Astarte borealis*, *A. montagui*, *Axinus sarsii*, *Bela harpularia*, *Cyprina islandica*, *Mytilus modiolus*, *Pecten islandicus*, *Trophon clathratus*, and *Zirphaea crispata*. A shell attributed to *Anomia patelliformis* is probably wrongly determined, as the species is much more southerly than any other.

The fauna is thus composed of 17 ax-forms, 12 a^{1}x-forms, and 1 bx-form, *Axinus sarsii*, whose distribution, however, is not well known. *Modiolaria corrugata* and *Tectura rubella* have their southern limits at Tromsö. The fauna resembles modern faunas on the Murman Coast.

Bathymetrically the fauna consists of 6 s-forms, 10 sd-forms, and 14 d-forms. *Balanus crenatus* predominates, while *Mytilus edulis* and *Saxicava* are fairly well represented and all the others poorly represented. The s-forms may have been washed down from the rocks behind the bed, whereas the d-forms can hardly have been washed up. Accordingly, and because some of the latter seem to require a water depth of 5 to 10 m, the bed may have been largely deposited on such a water depth. The percentage of pebbles is greatest in sample 1, and *Mytilus edulis* reaches a maximum in the middle of the bed and a minimum at the top, according to the statistic samples as well as ÖYEN's observations. At the top *Balanus crenatus* predominates. The cause of this is not known.

Sparöd.

Table p. 647.

1.5 km E of Bovallstrand, at Sparöd on the west side of the highway, some 66 m above sea level, 1917.

The bed is situated on the western slope of a valley, some 30 m from a rock ledge which rises steeply 15 to 20 m above it. It had been large and thick, but in 1917 only a small remnant remained. This was 0.75 m thick and overlain by a layer of cobbles and gravel 1 m thick. Samples were taken near the base and near the top. The lower part of the bed is clayey with few pebbles, the upper part contains numerous pebbles but no clay. On the whole the shells are of medium size, but a few are large. The fauna is low-arctic, its composition being 12 ax-forms and 5 a^{1}x-forms. *Rhynchonella* reaches its southern limit at Tromsö, and *Tectura virginea* reaches its northern limit of distribution on the Murman Coast.

The fauna is composed of 3 s-forms, 5 sd-forms, and 9 d-forms. By far most numerous are *Balanus crenatus* and *Saxicava.* Though the clayey bottom layers are much richer in *Mytilus* than the stony top layers, they were probably laid down in a depth of several meters, the shallow forms having been washed down from the adjacent rocks. The top strata may have been formed in shallow water and the superjacent cobbly bed in the shore line, and the whole deposit during regression.

Slätthult.

Table p. 647.

11 km S of Lysekil, 0.7 km E of Ellös, about 47 m above sea level, 1917.

The bed lies on a gentle eastward slope about 20 m to the east of rock ledges which rise 5 to 8 m above it. It has been rather extensive, but a great part has been removed. The thickness is unknown but is more than 1 m. Samples were taken at depths of 1 and 0.5 m and at the top.

The shell gravel is free from clay and only at the very top contains pebbles in noteworthy quantity. It consists quite predominently of small and medium-sized shells of *Balanus crenatus.* *Saxicava*, which is next in numbers, is also represented by small and thin shells, while *Balanus porcatus* is represented by large ones.

The fauna is low-arctic, being composed of 8 ax-forms and 7 a^{1}x-forms; its most temperate species, *Rissoa interrupta*, being dispersed as far as the Murman Coast and Bear Island.

With regard to the bathymetrical range the composition of the fauna is 4 s-forms, 6 sd-forms, and 5 d-forms. Among these latter *Pecten islandicus* and *Moelleria costulata*, both poorly represented, are not known to live in less depth than 9 m. Shallow forms and littoral forms are fairly numerously represented. As, furthermore, the bed was formed in the lee side of an island, so that both upwashing and downwashing of shells could take place, it is probable that the bulk if it was deposited in a water depth of 5 meters and less. The upward decrease of practically all forms, and especially the s-forms, is partly due to increase in size of the shells and partly to increase in mineral matter. Whether it is also due to increase in water depth is difficult to tell. It is perhaps equally probable that increased quantity of pebbles means that the top layer was laid down in the shore line.

Yllene.

Table p. 647.

10.5 km SE of Fjällbacka, 4 km NNE of Bottna Church, halfway between Gisslegärde and Yllene, probably some 50 m above sea level, 1915.

The shell bed occurs in a valley on the slope of the western wall, which at a distance of 20 m rises about 20 m above it. It slopes 20° to 25°. It presented the following section:

Topmost, 2 m relatively pure shell gravel with a few layers of sand. Samples 3 and 4, 0.5 m and 1.5 m from bottom of layer, respectively.
0.2 m shelly sand.
0.3 m sandy shell gravel. Sample 2.
0.6 m shelly sand.
0.4 m clayey shell gravel. Sample 1.
> 1 m shelly clay.

In the clay only a few shells of *Balanus crenatus* and *Mytilus edulis* were found. Samples 1 and 2 contain scattered pebbles, samples 3 and 4 numerous pebbles. In samples 1, 2, and 4 *Saxicava* and *Balanus porcatus* are largely represented by medium-sized and small shells, in sample 3 chiefly by large ones.

The fauna is composed of 14 ax-forms and 9 a^{1}x-forms. It is low-arctic, like that on the Murman Coast at the present time, up to which the most southerly species, *Tectura virginea*, is dispersed.

In bathymetrical respect the fauna consists of 6 s-forms, 6 sd-forms, and 11 d-forms. The bulk of the material is formed of *Balanus crenatus* and *Saxicava*. The clay at the bottom and the stony gravel at the top make it fairly certain that the bed was laid down during regression, the lower part in water several meters deep, the top part in the shore line. The heterogeneity of the fauna may be due to downwashing and upwashing.

Skistad.

Table p. 648.

5.5 km ENE of Fjällbacka, 0.7 km SE of Skistad Farm, about 51 m above sea level, 1917.

The bed is situated in a glen running in a northwest-southeast direction and at a distance of 40 m and 200 m from the walls which are some 10 m high. The bed is large and more than 2 m thick. It is said to be underlain by clay. Three samples were taken, viz. at depths of 2 m, 1 m, and at the surface. The material is sandy with few stones.

The fauna consists of 6 ax-forms and 8 a¹x-forms. The shells are of small size. The most southerly species, *Tectura virginea* and *Rissoa interrupta*, now extend up to the Murman Coast.

The bathymetrical composition of the fauna is 5 s-forms, 6 sd-forms, and 3 d-forms with the last-mentioned only poorly represented as regards individuals. The shell gravel consists largely of *Balanus crenatus*, *Littorina*, and *Mytilus* and was apparently laid down in water that was at most a few meters deep. The conditions do not indicate whether the deposition took place during rise or sinking of land.

Nordby.

Table p. 648.

4.5 km NE of Fjällbacka, 0.7 km NE of Nordby Farm, about 43 m above sea level, 1917.

The bed occurs in a pass and rests against a rock rising 6 m above it. On the opposite side of the glen, in the southeast, at a distance of 30 m rocks rise stepwise 20 to 25 m. The shell gravel is somewhat over 1 m thick. It is underlain by sand and overlain by a bed of shell-free gravel and sand 1 to 2 m thick. Samples were taken in the lower and upper parts. The lower sample contains a few pebbles, the upper none.

The fauna is distinctly low-arctic, of the composition 8 ax-forms and 5 a¹x-forms. The warmest species, *Verruca* and *Lacuna divaricata*, are dispersed up to eastern Murman ad the White Sea, respectively. The shells are medium-sized or small except for one large shell of *Saxicava* and one of *Pecten islandicus*.

Bathymetrically the composition of the fauna is 4 s-forms, 4 sd-forms, and 5 d-forms. The bulk of the shells are of *Balanus crenatus*, *Mytilus*, and *Littorina*. The upper sample is very rich in fragments of *Mytilus*, so that this species, as well as *Littorina*, perhaps increases upwards. The fragments of some of the d-forms may have been washed up, and the bed may have been formed in water that was a few meters deep and during regression. The deposition of shells was discontinued probably on account of too strong a current as the water depth decreased.

Hästekälla.

Table p. 648.

3 km N of Hälleviksstrand, on the west side of the highway at Hästekälla, 30 m N of Hästekälla I, about 35 m above sea level, 1917.

The bed occurs on the steep slope of the north-south valley. It extends up to about 35 m altitude; the surface at the exposure lay about 2 m lower. The bed is fairly large. It showed the following section:

Topmost, 0.5 m shelly coarse gravel. Sample 3.
1.5 m shell gravel with predominating *Mytilus*. Samples at bottom and 1 m above bottom.
Sand.

The top gravel has a very different fauna from the lower gravel and is probably younger than this. It will be treated on page 604.

The two lower samples contain little mineral matter. The fauna is composed of 3 ax-forms and 4 a^{1}x-forms and is consequently low-arctic. The warmest form, *Rissoa interrupta*, now extends as far as the Murman Coast. The high-arctic species are represented by small or medium-sized shells.

The lowest sample consists largely of fragments of *Mytilus*, the second sample of fragments of *Mytilus* and *Balanus crenatus*. D-forms are represented by only a few specimens of two species. The bed was perhaps laid down in shallow water during transgression. However, it may have been formed on fairly great depth by downwashing, though this seems less probable in view of the poor representation of d-forms. The bed occurs at about 30 per cent of the marine limit.

Lur.

Table p. 648.

15 km NNE of Gräbbestad, 1 km N of Lur Church, about 59 m above sea level, 1915. Probably the same bed as determined by Hägg (1924, p. 475) at 60.3 m.

The shell bed occurs on a gentle slope. There are no elevations worth mentioning in the vicinity. The deposit is 0.5 m thick and underlain by sand. Samples were taken of the lower and the upper part. The lower sample is very stony, the upper one fairly so and furthermore consists of finer material.

The bed contains several molluscs that are sparcely dispersed in the low-arctic regions and *Abra* which is not met beyond Hammerfest. The composition is 8 ax-forms, 10 a^{1}x-forms, and 1 bx-form.

Bathymetrically the composition is 7 s-forms, 7 sd-forms, and 5 d-forms. The last-mentioned are poorly represented as regards individuals. By far the most numerous are *Balanus crenatus*, *Mytilus*, *Littorina*, *Saxicava*, and *Verruca*. The bed agrees in composition, consistency of material, and insignificant thickness with modern upwashed beds; and it may have been deposited in the shore line or in very shallow water.

Lyrön.

Table p. 648.

3 km NE of Mollösund, at Lossbo on Lyrön, about 29 m above sea level, 1917.

The shell bed occurs in a depression whose surrounding rocks rise on the average about 3 m above it. It is large but has been partly removed. Locally its thickness may have amounted to a few meters. An exposure was 1.7 m high. Samples were taken at depths of 1.7 and 0.85 m and at the surface. The two lower samples contain fairly numerous stones, the top sample only solitary pebbles.

The fauna is composed of 15 ax-forms, 9 a^{1}x-forms, and 2 bx-forms. The most southerly species, *Cardium edule* and *Gibbula cineraria* now reach their northern limits at Öksfjord and Vardö, respectively. The shells of *Cardium edule* and *Littorina littorea* in sample no. 2 are large. Those of *Saxicava* and *Balanus porcatus* are also partly large and thick.

The bathymetrical composition is 5 s-forms, 10 sd-forms, and 10 d-forms. The d-forms are represented by few individuals. The most numerous species are *Balanus creatus*, *B. porcatus*, *Saxicava*, and *Mytilus*. *Mytilus* and *Lacuna divaricata* reach maxima in the the middle horizon of the bed, *Balunus porcatus* at the bottom, and *Balanus crenatus* at the top. The percentage of mineral gravel is much greater in the middle than at the top. These conditions tend to suggest that the middle layers were formed in shallower water than the bottom or the top strata and that the bed marks a regression limit. However, the variations in frequency of other species make this possibility doubtful. The bed may have been formed during regression, when the water level stood a few meters above it. The downwashing was at most 5 m. The situation excludes redeposition. The bed lies at about 35 per cent of the marine limit.

Stensbo.

Table p. 648.

2 km NNE of Hälleviksstrand, at Bräcke Farm, about 26 m above sea level, 1917.

The shell bed lies at the widening of a narrow valley. It rests against bed rock which at a distance of about 60 m in northeasterly direction rises some 5 m above it. It has a large extent and a thickness of more than 3 m. The strata dip 10° towards the west. Samples were taken and analyzed at depths of 3, 2, and 1 m and at the surface.

The shell gravel consists to about 50 per cent of pebbles and sand. The balanids are represented by small shells, *Saxicava* by solitary large shells. In a picking the following species not met with in the statistical sample were obtained: *Astarte borealis*, *Buccinum undatum*, and *Zirphaea crispata*. The composition of the fauna is 11 ax-forms and 8 a^{1}x-forms. The most southerly species are *Tectura virginea* and *Gibbula tumida*, which at present extend as far as the Murman Coast.

The composition of the fauna as regards the vertical distribution of the species is 5 s-forms, 6 sd-forms, and 8 d-forms. The latter are all poorly represented, and most of them can go in on very shallow water. The species occurring in the greatest mumbers, *Balanus crenatus*, *Mytilus*, and *Saxicava*, are frequent in very shallow water. The absence of elevations excludes the possibility of the shells having been washed down more than a few meters.

The presence of numerous and large cobbles in the material and their upward increase suggest deposition at insignificant depth or in the shore line and probably in decreasing depth. The composition of the fauna does not change materially. Most probably the lower part of the bed was formed in a depth of some 5 m, and the top in the shore line. But the whole bed may be a shore deposit formed during transgression of the sea.

The bed occurs at about 20 per cent of the marine limit, this probably lying at about 120 m.

Sanderöd.

Tabl. p. 649.

4.5 km SSE of Hunnebostrand, 2 km SSW of Askum Church, 0.7 km W of Sanderöd, about 23 m above the sea, 1917.

The shell bed occurs in the northernmost part of a glen running somewhat east of north. On the western side rocks rise fairly abruptly 20 to 25 m above the bed, and in the north moderately steeply some 20 m. The samples were taken 40 m and 20 m respectively from the two rock walls. The shell bed is very extensive. It slopes gently towards the south-southeast and the south, while the ground otherwise is mainly level. Is is 1.8 m thick and rests on rock. The bottom layers of the bed are strongly clayey. All parts of the deposit contain only scattered pebbles.

The fauna is high-boreal with 10 ax-forms, 10 a^lx-forms, 4 bx-forms, and 1 b^mx-form. *Abra alba* is dispersed as far as Lofoten; and *Montacuta bidentata*, *Craspedochilus marginatus*, and *Cardium edule* reach their northern limits at Hillesöy, Tromsö, and Öksfjord, respectively.

As regards the vertical distribution of the molluscs the fauna contains 8 s-forms, 8 sd-forms, and 9 d-forms. The last-mentioned play a subordinate rôle, whereas *Mytilus* and *Balanus crenatus* are represented by the greatest number of individuals. The whole bed with the exception of the bottom strata may have been formed in very shallow water. Whether the next topmost sample was deposited in the shallowest water is difficult to determine, as *Mytilus* and *Lacuna* reach maxima in the former and *Littorina* and *Cardium edule* in the latter. The bottom layers, as being strongly clayey and containing but few s-forms and lacking brackish water species, may have been laid down in deeper water than any other part. The bed may, therefore, have been largely or entirely formed during regression.

Glimsås.

Table p. 649.

12 km S of Lysekil, 2 km SE of Ellös, on the eastern side of the highway opposite the road to Glimsås, probably about 20 m above the sea, 1917.

The deposit occurs in a valley at the foot and on the slope of a hill which rises rather steeply some 10 m above the spot at which the sample was taken. It is a clayey, shell-bearing gravel more than 1 m thick and is overlain by a bed of pure mineral gravel 0.5 m thick. It covers a fairly large area. Several shells of *Zirphaea* and *Mya* were observed in an upright position with both valves together, in the position in wich they lived. Besides the species represented in the statistical sample the following ones were observed: *Littorina littorea-rudis*, *Lucina borealis*, *Lunatia intermedia*, *Neptunea despecta*, *Pecten islandicus*, and *Zirphaea crispata*.

The fauna is high-boreal, consisting of 9 ax-forms, 6 a¹x-forms, and 3 bx-forms. The warmest species, *Montacuta bidentata* and *Cardium edule*, are dispersed to Hillesöy and Öksfjord, respectively.

As regards the depths preferred by the molluscs, the fauna contains 5 s-forms, 5 sd-forms, and 8 d-forms. No species is richly represented. The shell gravel may have been formed in water a few meters deep, and the covering mineral gravel in the shore line.

Huseby.

Table p. 649.

12.5 km. S of Lysekil, 2 km S of Ellös, just W of Huseby some 10 to 20 m above sea level, 1917.

The shell bed occurs in a narrow glen at the foot of a steep rock 6 to 8 m high. It is extensive and more than 1.5 m thick. It is covered by mold 2 dm thick. Two samples were taken, one at a depth of 1 m, another near the top. The shell gravel is rather stony.

The fauna consists of 10 ax-forms, 6 a¹x-forms, and 1 bx-form. *Montacuta bidentata* of the last group is dispersed as far as Hillesöy. *Saxicava* and *Balanus porcatus* are large-sized.

Bathymetrically the fauna contains 5 s-forms, 4 sd-forms, and 8 d-forms. The most frequent species are *Balanus crenatus*, *Saxicava*, and *Littorina*. Practically all species are more numerous at the top than in the lower sample. Both downwashing and upwashing may have taken place; and the bed may have been formed at a depth of a few meters but hardly as many as ten, as the d-forms are subordinately represented. The bed lies at about 17 per cent of the marine limit.

Morlanda.

Table p. 649.

10.5 km SSE of Lysekil, 1.7 km NNE of Morlanda Church, on the brook and the road, about 5 m above sea level, 1917.

The bed occurs at the foot of a precipitous rock some 15 m high. It slopes somewhat, is fairly large, and is more than 2 m thick. One sample was taken near the surface. The material contains much more pebbles and sand than shells. The very topmost part of the bed contains shells of *Ostrea* and is clayey. It may be essentially younger than the bulk of the deposit.

The fauna has the composition 7 ax-forms, 3 a^1x-forms, and 4 bx-forms. *Saxicava* and *Balanus porcatus* are represented by large shells. The warmest species, *Solen ensis* and *Corbula gibba*, extend to Öksfjord and Hammerfest, respectively.

Bathymetrically the fauna consists of 2 s-forms, 8 sd-forms, and 4 d-forms. All the species except for *Balanus crenatus* and *Mytilus* are poorly represented, as the material is shelly mineral gravel, is a typical shore deposit. This is important as it shows that the shore line receded at least to 5 m above its present stand while the temperature of the water was like that in Vestfinnmark today. As the bed is more than 2 m thick, its lower, inaccessible strata may have been formed in water of some depth. The bed occurs at about 4 per cent of the marine limit.

Hermanö I.

Table p. 649.

13.5 km S of Lysekil, the central part of east coast of Hermanö, a few meters above sea level, 1917 and 1919.

The shell bed occurs near the shore. The surrounding rocks are low with gentle slopes. The highest rocks, i. e. those at some distance to the north, rise only 15 to 20 m above the shell bed. The shell deposit slopes gently towards the sound. It has a diameter of about 100 m and a thickness of at least a few meters. Two series of samples, A and B, were taken.

A. — Top of bed 3.5 m above the sea. Cut 2.5 m deep. Substratum not reached. The shell gravel is overlain by a layer of mold a few decimeters thick. Four samples were taken. Below the lowest sample clayey *Mytilus* gravel. The shell gravel is practically free from pebbles.

The uppermost sample contains solitary specimens of *Bittium* and *Odostomia albella* which are dispersed only as far as Trondhjem and Bergen respectively and which may be mixed in later; if not, the entire layer is post-glacial. The layer will be treated on page 634.

The fauna of the three lower samples contains 6 ax-forms, 9 a^1x-forms, 6 bx-forms, and 1 b^mx-form — *Thracia villosiuscula*. It is high-boreal. *Mytilus edulis* is the dominating species. Bathymetrically the composition is 5 s-forms, 12 sd-forms, and 5 d-forms. Except for *Mytilus* and *Balanus crenatus* all forms are represented by few individuals. The bed gives the impression of being a shore deposit throughout. If it is so, transgression must have proceeded as the bed grew, for it is some 2.5 m thick. However, the large extent and the upward increase of *Mytilus* may mean that the bed was formed in water a few meters deep and during shallowing due to deposition. Whichever was the mode of formation the shore line at the time must have been only a few meters above the present stand.

B. — About 35 m from series A, nearer the shore. Surface of bed 3 m above sea level. At this place the following section vas exposed:

Topmost, 2.5 dm mold.
3—5 dm post-glacial shell gravel.
0—1 dm cobbly gravel. Erosion remnant.
Thick *Mytilus* gravel. Same as in series A.

Here, consequently, the same bed as is exposed at A, was eroded as indicated by a distinct limit and a layer of cobbles and coarse gravel; and upon the surface of erosion a shell bed of very different appearance, a typical post-glacial bed, was deposited (p. 635). Of the lower bed one sample was taken 1 dm below the erosion level, at an altitude of 2.1 m. This sample will be considered here. The material is practically free from mineral matter.

The fauna is high-boreal, of the composition 7 ax-forms and 7 a^1x-forms. In bathymetrical respect the fauna consists of 5 s-forms, 6 sd-forms, and 4 d-forms. *Balanus crenatus* and *Mytilus* predominate. The shell bed is a shallow-water or littoral deposit.

Tången II.

Table p. 649.

2 km NNE of Mollösund, on the Tångesund, 2 m above sea level, 1917.

The shell bed lies on even ground; only in the south are there rock ledges rising some 7 m. The bed is extensive and is used as a cemetery. Its thickness is unknown but is more than 1.7 m. Samples were taken at depths of 1.7 and 0.85 m and at the surface. The lowest sample is clayey and almost lacking in coarse mineral matter. Sample 2 contains scattered pebbles. Sample 3 is sandy, clay-free gravel rich in shells. The structure of the bed does not show any break, but the topmost sample has a considerably warmer fauna than the two lower ones. The true post-glacial molluscs here may have been mixed in later during a slight redeposition of the older shells. Thus the surface layer may have been formed in late Ancylus time or during the latter part of the last upheaval. It will be treated on page 612.

The fauna of the two lowest samples has the composition 5 ax-forms, 9 a^lx-forms, 6 bx-forms, and 1 b^mx-form. The warmest species, *Actaeon tornatilis*, now extends as far as Lofoten. Several species have their northern limits between Tromsö and Öksfjord.

As regards the depth which the molluscs prefer the fauna consists of 5 s-forms, 8 sd-forms, and 8 d-forms. The d-forms are poorly represented. *Mytilus edulis* predominates; and *Balanus crenatus*, *Lacuna divaricata*, and *Littorina* come next in numbers. Accordingly, and because adjacent elevations are lacking, the bed may have been formed in very shallow water; and the sea level may have stood only a few meters above its present height.

Post-glacial beds.

Beds from the Ancylus sinking.

Gudebo.

Table p. 654.

13 km ESE of Strömstad, 5 km E of the railroad, 0.5 km SE of Gudebo, surface at about 48, shell bed at 46.3 m above sea level. G. De Geer, 1894.

The following section was observed by De Geer:

Topmost, 1.4 m sand, fine at bottom, gravelly at top.
0.4 m clay.
0.05 m shell gravel.
Thick sand.

Beside species represented in the statistic sample the following ones occur in pickings:

Astarte elliptica
Cardium echinatum
Macoma calcaria
» *baltica*
Ostrea edulis
Patella vulgata
Pecten islandicus
Puncturella noachina
Tapes aureus
» *pullastra*
Utriculus umbilicatus

Part of the shells of *Saxicava* are large and thick and are redeposited from an older bed. Also other arctic species perhaps occur in secondary position. The composition of the fauna is 9 ax-forms, 6 a^lx-forms, 6 bx-forms, 1 b^mx-form, and 3 b^lx-forms. The warmest species are *Tapes aureus*, now extending northward to Bergen and the Oslofjorden, and *Nassa reticulata* and *Ostrea* dispersed as far as the Trondhjemsfjorden. As regards the vertical distribution of the molluscs the fauna is composed of 8 s-forms, 7 sd-forms, and 10 d-forms. The last-mentioned play a subordinate rôle because of few individuals. By far most numerous are *Hydrobia*, *Balanus crenatus*, and *Littorina*. The conditions of occurrence of the bed are not known to the writer, so that decided preference cannot be given to any particular view. But the shell layer may have been formed either at or near the shore, the superjacent clay during a later transgression, and the top layer during the final regression. Or the shell gravel may possibly have been deposited at some depth by downwashing, and the overlying clay, sand, and gravel later during the same regression. The deposit lies at about 30 per cent of the marine limit.

Skårbo.

Table p. 654.

3.5 km N of Gräbbestad, 0.5 km E of the Sannäsfjärden, 0.5 km SSW of Skårbo, about 46 m above the sea, 1915.

The bed occurs on the inner side of a narrow pass. It is 1.8 m thick and is underlain by sand. Samples were taken near the bottom, 1 m above, and at top. The lowest part of the bed is strongly clayey. The whole bed has a fairly large percentage of pebbles.

The fauna is largely composed of low-arctic and high-boreal species and contains 7 ax-forms, 9 a^1x-forms, 6 bx-forms, and 2 b^mx-forms. The northern limit of distribution of *Nucula nucleus* and *Thracia* lies at Lofoten.

Bathymetrically the composition is 5 s-forms, 11 sd-forms, and 8 d-forms. *Mytilus* and *Balanus crenatus* are by far most numerous. As occurring in similar position to the modern Smalsundet (p. 499), the bed may have been formed in a similar way, i. e. in shallow water and in the shore line of molluscs living on the spot and in the vicinity in deeper and shallower water.

Knutsdalen.

Table p. 654.

2.5 km E of Hunnebostrand, 1 km N of Knutsdalen, about 54 m above sea level, 1917.

The bed occurs at the highest part of a north-southerly glen 50 m wide. In the southwest, at a distance of 25 m, rocks rise from 5 to 8 m above the bed. This is covered by a layer of sand, a few decimeters thick. The bed is of unknown thickness. Two samples, at a depth of 1 m and at top, were taken. The lower sample is little stony, the upper one fairly stony.

The composition of the fauna is 8 ax-forms, 8 a^1x-forms, and 3 bx-forms. The warmest species, *Lepidopleurus cinereus* and *Cardium edule*, reach their northern limits in the Kvænangen and the Öksfjorden, respectively. Some of the shells of *Saxicava* and *Balanus porcatus* are thick and large.

Bathymetrically the composition of the fauna is 8 s-forms, 6 sd-forms, and 5 d-forms. The most numerous species are *Balanus crenatus*, *Mytilus*, *Lacuna divaricata*, and *Saxicava*. The bed apparently was laid down in very shallow water in a situation comparable to that in the Smalsundet. *Mytilus*, *Littorina*, and *Lacuna* decrease in numbers upwards, whereas the percentage of mineral gravel increases in the same direction, so that no conclusion regarding the movement of the shore line can be made.

Beds from the late Ancylus uplift.

Bredhult.

Table p. 654.

9.5 km N of Strömstad, 4 km W of Hogdal Church, 1 km W of Bredhult, about 71 m above the sea. G. De Geer, 1893. (See p. 545.)

The bed occurs 40 m west of a pass. It presented the following section:

Topmost, 0.2 m shore gravel.
1.1 m shell gravel.
$>$ 0.5 m clayey sand and gravel.

The shell bed contains scattered pebbles and consists in large part of fragments of *Mytilus edulis.* Samples were taken in the lower and the upper part of the shell gravel. Besides the species represented in the statistical samples, the following have been found in pickings:

Astarte elliptica
Boreochiton marmoreus
Cardium exiguum
Cyprina islandica
Gibbula tumida
Lepeta coeca
Littorina littorea-rudis
Lunatia intermedia
Macoma baltica
» *calcaria*
Mytilus modiolus
Ostrea edulis
Thracia villosiuscula

The composition of the fauna is 11 ax-forms, 13 a^{l}x-forms, 5 bx-forms, 3 b^{m}x-forms, and 1 b^{l}x-form. Thus, the fauna is on the whole high-boreal. However, *Ostrea* reaches it present northern limit in the Trondhjemsfjorden, and *Lunatia intermedia*, *Parthenia interstincta*, and *Thracia villosiuscula* at Lofoten.

Bathymetrically the composition of the fauna is 5 s-forms, 14 sd-forms, and 14 d-forms. The last-mentioned are represented by few individuals. The most numerous species it *Mytilus.* The occurrence of the shell bed near a pass point, the fauna, and the overlying coarse mineral gravel, show that the bed was formed in water a few meters deep essentially of shells living on the spot and such as were washed up by waves. It may have been formed during regression to judge from the upward increase of *Mytilus.*

The bed lies at about 43 per cent of the marine limit.

Skärjedalen.

Table p. 654.

12 km N of Strömstad, 4.5 km NW of Hogdal Church, 0.7 km SW of Skärje, according to Hägg (1924, p. 477) 63 m above sea level. G. De Geer, 1893. (See p. 549.)

The bed is situated in a narrow pass. One sample has been analyzed. The material is fairly stony. In a picking the following species, not found in the statistic sample, were met with:

Anomia striata
Astarte elliptica
Lepeta coeca
Patella vulgata
Skenea planorbis
Solen ensis
Tapes pullastra

The composition of the fauna is 7 ax-forms, 8 a^{l}x-forms, 10 bx-forms, 5 b^{m}x-forms, and 1 b^{l}x-form. The most southerly species, *Lepton nitidum*, is now distributed northward to Bergen and the Oslofjorden. The presence of this form can hardly be taken to mean that the water had the same temperature as on the Norwegian West Coast today, for all other species are distributed at least as far as Lofoten.

Bathymetrically the composition is 9 s-forms, 13 sd-forms, and 11 d-forms. The last-mentioned are poorly represented. The most common species are *Balanus crenatus*, *Littorina*, *Mytilus*, and some small forms. The bed may be an upwashed littoral one.

Skärje.

12.5 km N of Strömstad, NW of Skärje, according to Hägg (1924, p. 477) 60 m above sea level. G. De Geer, 1893.

From this bed a picking containing the following species is at hand:

Aporrhais pes pelicani
Astarte elliptica
» *montagui*
Cardium echinatum
Littorina rudis
Mya truncata
Mytilus edulis
Saxicava arctica
Venus gallina

Hägg mentions *Dentalium entale*, *Emarginula fissura*, and *Hinnites pusio*.

The most southerly species are *Hinnites*, now distributed as far as the Trondhjemsfjorden, and *Apporrhais* and *Cardium* distributed as far as Vannöy and Kvænangen in Vestfinnmark, respectively. A picking of this kind is not sufficiently characteristic to permit any estimate of the depth of deposition.

Oxtorp.

Table p. 654.

8 km ESE of Strömstad, 3 km SE of Skee Station, 1 km N of Oxtorp, about 50 m above sea level. G. De Geer, 1890.

The shell bed is situated in a glen. It is more than 1 m thick. It is overlain by a layer of cobbly shore gravel 0.5 m thick. One sample from the upper part of the bed has been analyzed. The following species have been found in the bed beside those represented in the sample:

Anomia striata
Astarte elliptica
Balanus hameri
Boreochiton marmoreus
Lepeta coeca
Lucina borealis
Lunatia intermedia
Macoma baltica
» *calcaria*
Mytilus modiolus
Nassa incrassata
Patella vulgata
Pecten islandicus
Tapes pullastra
Tectura virginea

The composition of the fauna is 10 ax-forms, 11 a^lx-forms, 8 bx-forms, 3 b^mx-forms, and 3 b^lx-forms. Part of the *Saxicava* shells are large and are evidently redeposited. So are perhaps other shells. The warmest species represented are *Lepton nitidum* and *Tapes virgineus*, extending northward to the Oslofjorden and the Norwegian West Coast, and *Cardium norvegicum* extending as far as the Trondhjemsfjorden.

Bathymetrically the composition is 9 s-forms, 14 sd-forms, and 12 d-forms. The most numerous species are *Balanus crenatus*, *Littorina*, and *Mytilus*. Judging from the fauna, the bed might be an upwashed littoral formation, but the overlying coarse gravel, evidently formed in the shore line, seems to exclude this possibility. Though the conditions of occurrence are not known to the writer, it seems most likely that the bed was largely formed through downwashing of shells.

The marine limit being at about 160 m the bed lies at about 35 per cent of it.

Ullerö.

Table p. 654.

9.5 km E of Fredrikstad, 800 m SSW of Ullerö Church, on the west side of the road, about 59 m above sea level, 1917.

The shell deposit occurs on a gentle slope, the ground finally rising a few meters above the bed. It is a few decimeters thick and is underlain by sand. It contains but little mineral matter and consists largely of *Littorina* and fragments of *Mytilus*. It is a typical littoral formation.

The fauna is very poor, being made up of 1 ax-form, 5 a^1x-forms, 3 bx-forms, and 4 b^1x-forms. The most southerly species, *Rissoa parva*, has its present northern limit in the Nordfjorden. Bathymetrically the fauna contains 5 s-forms, 7 sd-forms, and 1 d-form. *Hydrobia minuta* and *H. ulvae* suggest diluted water.

Tose.

Table p. 654.

9 km SE of Fredrikstad, 1 km W of the Tosekilen and 800 m NW of the crossroads at Tose, about 57 m above sea level, 1917.

The bed lies between to rocky ridges 1 and 3 m high respectively. Is is fairly large and 1.2 m thick. It is underlain by coarse sand. Samples were taken at bottom, 0.6 m above bottom, and at top. The mineral content is insignificant.

The fauna consists of 5 ax-forms, 10 a^1x-forms, 7 bx-forms, 2 b^{III}x-forms, and 6 b^1x-forms. The low-boreal species are represented by few individuals. In bathymetrical respect the fauna contains 8 s-forms, 17 sd-forms, and 5 d-forms. *Mytilus* predominates in the lower and greater part of the bed, *Littorina* and *Mytilus* in the top layers. The lower part may have been deposited in very shallow water, the upper part in the very shore line.

Hästekälla.

Table p. 654.

See page 591. Here the capping shore gravel will be treated. This contains coarse sand as the finest material. It is rich in shells.

The fauna is composed of 4 ax-forms, 5 a^1x-forms, and 4 bx-forms. The representatives of the last group, *Cardium edule*, *Patella vulgata*, *Solen ensis*, and *Tapes pullastra*, reach their northern limits between Tromsö and Hammerfest. Of the species 8 are s-forms, 3 sd-forms, and 2 d-forms. *Balanus crenatus* and *Littorina* predominate completely. These conditions together with the course mineral gravel indicate that the layer was deposited in the shore line.

Udden I.

Table p. 655.

5 km S of Fjällbacka, 2 km SSE of the northern end of the Hombergsund, at Udden, about 36 m above sea level, 1917.

The large bed is situated at the foot of a rock ledge rising about 20 m above it. In 1917 it was exposed in a long fresh road cut on the west side of the road. The stratification is conformable. The bed is more than 3 m thick; the bottom was not exposed. It is overlain by a bed of cobbles and large boulders piled up at very steep angle. Samples were taken at depths of 3, 2, 1, and 0.5 m and at the top. The material of the lowest sample is fairly clayey and that of the other samples somewhat clayey. The material throughout the bed contains scattered pebbles and a little sand. The fractions less than 2 mm consist largely of fragments of *Balanus crenatus*, *Mytilus*, and other animals.

The fauna of the lowest sample is composed of 4 ax-forms, 7 a^{1}x-forms, 3 bx-forms, and 3 b^{1}x-forms, those of the last group being *Bittium*, *Rissoa parva*, and *Triforis*. The fauna of the whole bed contains 4 ax-forms, 11 a^{1}x-forms, 10 bx-forms, 4 b^{111}x-forms, and 6 b^{1}x-forms. Thus, the fauna does not change much throughout the thick bed. The b^{1}x-forms, with the exception of *Rissoa parva*, are all present in few individuals. The bed may be early post-glacial.

Bathymetrically the fauna contains 8 s-forms, 18 sd-forms, and 9 d-forms. *Balanus crenatus* and *Mytilus edulis* play by far the greatest rôle. The latter reaches a maximum in sample 2; *Littorina* and *Lacuna divaricata* in sample 4. The d-forms are represented by few individuals. The bed may have been deposited in water less than 10 m deep.

Lavö.

Table p. 655.

11.5 km S of Lysekil, Lavö, 300 m SW of Källsnäs, about 20 m above sea level, 1917.

The shell deposit occurs in a valley 75 m wide. The adjacent rock ledges rise 8 to 10 m above the valley bottom. The deposit is very extensive and more than 2 m thick. A large quantity of shell gravel has been removed. Samples were taken from depths of 2 and 1 m and from the top. The pebbles decrease upward from a fairly large to an insignificant percentage. *Mytilus* fragments play a great rôle in the lower part. Beside the species occurring in the analyzed samples, the following were found in the bed: *Cardium edule*, *Lucina borealis*, *Tapes aureus*, and *T. pullastra.*

The lowest sample contains only 3 ax-forms, 6 a^1x-forms, and 5 bx-forms. The warmest species are now distributed as far as Vestfinnmark. Sample 2 consists of 4 ax-forms, 4 a^1x-forms, 2 bx-forms, and 1 b^1x-form. The representative of the last group, *Bittium*, was found in only one individual and is possibly a later addition. *Balanus crenatus* and *Mytilus edulis* predominate in both samples. The shells of *Balanus* and *Saxicava* are small. The top sample contains 5 ax-forms, 13 a^1x-forms, 15 bx-forms, 2 b^mx-forms, and 6 b^1x-forms; i. e. the composition is like that of some modern beds. *Tapes aureus* extends as far as Bergen and the Oslofjorden.

Bathymetrically the two lowest samples consist of 5 s-forms, 10 sd-forms, and 2 d-forms. If fragments also are taken into account *Mytilus* is the dominating species. *Littorina* and *Lacuna* are rather numerous. The material contains a fair quantity of mineral gravel. Thus, this part of the bed was formed either in very shallow water or in the shore line. The top sample consists of 11 s-forms, 23 sd-forms, and 7 d-forms. The d-forms are poorly represented, whereas *Mytilus* and *Littorina* are among the most numerous. This part of the bed was also either washed up on the shore or laid down in very shallow water. The upper part of the bed and probably also the middle part may be derived from late Ancylus time. The bottom layers are perhaps derived from early Ancylus time, though the stratification does not show any break.

Fyka.

Table p. 655.

3.5 km SW of Hunnebostrand, 1.3 km E of Fyka, the southern one of the two beds indicated on the geological sheet, about 23 m above sea level, 1917.

The bed is situated in a valley near its junction with another valley. It probably has a very large extent. On the southeastern side, at a distance of about 20 m, bed rock rises perpendicularly to some 20 m above the bed. On the west and northwest sides rock ledges rise only a few meters. The bed is covered by a layer, 1 to 2 dm thick, of coarse mineral gravel. It is more than 3 m thick; the bottom was not reached. The lowest sample is clayey and free from pebbles. Sample 2 is somewhat stony, and the other samples rather stony, especially sample 3.

The fauna consists of 5 ax-forms, 8 a^1z-forms, 3 bx-forms, 1 b^mx-form, and 4 b^1x-forms, i. e. it indicates temperature conditions like those existing today on the coast of Bohuslän. However, the southerly species are represented by very few specimens.

The bathymetrical composition is 6 s-forms, 10 sd-forms, and 5 d-forms. The last-mentioned are few in number. *Mytilus* and *Balanus crenatus* play by far the greatest rôle. The whole bed evidently was deposited in very shallow water, not in deep water after downwashing of the littoral shells, as the scarcity of the d-forms shows. The high percentage of pebbles in sample 3, and the maximum of *Mytilus* in sample 4, perhaps mean that this horizon was deposited in shallower water than the other parts of the bed, that the lower part was formed during uplift, the upper part during sinking. The great thickness of the shell gravel, all apparently formed in very shallow water, indicates the same thing. The coarse top gravel may date from the last passing of the shore line.

Lersten.

Table p. 655.

0,7 km E of Fjällbacka, just S of Lersten Farm and the highway, some 19 m above sea level, 1917.

The bed rests on a hillside sloping 10° to 15°. At a distance of a few tens of meters rocks rise some 15 to 20 m above the uppermost sample in the series. The bed is very large, but its actual extent is not determinable from the ground surface. Large quantities of shells have been removed. A series of samples was taken in a section 4 m high 125 m south of the highway. The substratum is sand. The lowest part of the bed is clayey *Mytilus*-gravel with few pebbles. Samples 2, 3, and 4 consist largely of *Balanus crenatus* with few pebbles, and the top sample of *Mytilus;* these samples have no clay.

The composition of the fauna is 8 ax-forms, 9 a^1x-forms, 6 bx-forms, 1 b^mx-form, and 2 b^1xforms. The two most southerly species, *Lepton nitidum* and *Rissoa parva*, now distributed up to Bergen and the Nordfjorden, respectively, occur in samples 2 and 3. They cannot have been mixed in during post-glacial time, as the local conditions practically exclude extensive redeposition of the shell gravel; but they may occur in original position.

In bathymetrical respect the composition of the fauna is 5 s-forms, 10 sd-forms, and 11 d-forms. The last-mentioned are few in individuals. The dominating species are *Mytilus* and *Balanus* *crenatus*. *Mytilus* forms perhaps an upward-increasing percentage. The d-forms are with one exception limited to the three lowest samples. The material changes from clayey at the bottom to strongly sandy near the top. Thus, the bed seems to have been deposited during regression. As it is at least 4 m thick, the bottom layers must have been deposited in water that was several meters deep; and *Mytitus* and other s-forms may have been washed down because of the too great steepness of the hillside.

Klevekilen II.

Table p. 656.

13.5 km NNW of Lysekil, on the E side of the Klevekilen, 1 km N of the end of the peninsula, 40 m SW of Klevekilen I, about 17 m above sea level, 1917.

The bed occurs 25 m N of a rock ledge which rises about 25 m. It is a few decimeters thick. The material consists predominantly of *Mytilus edulis* and large shells of *Mytilus modiolus*. It contains but little mineral matter. *Saxicava* is partly represented by large late-glacial shells which must occur in secondary position.

The composition of the fauna is 8 ax-forms, 11 a^{l}x-forms, 7 bx-forms, 4 b^{m}x-forms, and 3 b^{l}x-forms. The warmest species, *Rissoa parva*, now extends as far as the Nordfjorden. The fauna is colder than the modern ones.

Bathymetrically the fauna contains 6 s-forms, 17 sd-forms, and 10 d-forms. *Mytilus* is the predominating species. *Littorina*, *Lacuna*, and *Purpura* are poorly represented. The bed may have been laid down in water that was a few meters deep.

Klevekilen I.

Table p. 656.

13.5 km NNW of Lysekil, on the east side of the Klevekilen, and 0,5 km N of the southern end of the peninsula, about 13 m above sea level, 1917.

The shell bed is extensive, probably covering the whole valley bottom. About 50 m to the south of the exposure rocks rise steeply some 30 m. At an equal distance to the east rocks rise about 10 to 15 m. The bed is excellently exposed in a large pit. Two series of samples, A and B, were taken, 15 m apart in the section.

A. — The bed shows here the following profile:

Topmost, 0.4 dm shell gravel. Sample 3 (p. 627).
1.2 dm shell-free clay, resting on an uneven surface and wedging out in both directions of the exposure.
6 dm shell gravel, with eroded surface. Samples at bottom and top.

At this place the lower bed will be treated. The material is rather stony and sandy and somewhat clayey. The fauna is composed of 8 ax-forms, 9 a^lx-forms, 9 bxforms, 4 b^mx-forms, and 7 b^lx-forms and is thus comparable to the modern faunas. As regards the depth preferred by the molluscs, it is formed of 7 s-forms, 18 sd-forms, and 15 d-forms. The bed may have been deposited in water that was several meters deep and, judging from the eroded surface, during regression. The covering clay was probably laid down during the subsequent Tapes submergence, and the top gravel during the last regression.

B. — 15 m west of A. Here only the lower shell bed is present. It is 1.8 m thick and with undisturbed stratification. It is underlain by clay and fine sand. Four samples were taken, viz. near the bottom, 0.9 and 0.45 m below the top, and at the top. The material throughout the bed contains scattered pebbles and some sand.

The lowest sample contains only *Balanus crenatus*, *Mytilus*, *Mya*, and *Littorina*, and consists almost wholly of the first-mentioned. All these molluscs extend as far as the Barents Sea or farther. This part dates perhaps from earliest post-glacial time. Sample 2 contains 4 ax-forms, 7 a^lx-forms, 6 bx-forms, 1 b^mx-form, and 3 b^lx-forms. The warm species are poorly represented. Samples 3 and 4 have about the same kind of fauna. Their combined fauna consists of 7 ax-forms, 9 a^lx-forms, 12 bx-forms, 4 b^mx-forms, and 4 b^lx-forms. The last group is represented by few individuals. The fauna is thus colder than that at A.

Bathymetrically the fauna of sample 1 consists of 2 s-forms, and 2 sd-forms; the fauna of sample 2 of 5 s-forms, 11 sd-forms, and 5 d-forms; and the fauna of samples 3 and 4 together of 7 s-forms, 18 sd-forms, and 11 d-forms. Thus the percentage of d-forms increases. However, the typical s-forms do not undergo any noteworthy change in numbers, so that it is uncertain whether the bed was formed during transgression or not. The depth of formation may have been 5 to 10 m.

Fossa.

Table p. 656.

7 km S of Lysekil, 2 km E of Grundsund Church, on the road just N of Fossa, about 11 m above sea level, 1917.

The shell bed is situated at the western foot of a rock ledge, rising abruptly 15 m. It presented the following section:

Topmost, 1.5 dm mold.
5 dm Ostrea gravel. Sample from middle. See page 623.
(Rather sharp limit. Break in deposition.)
5 dm fine shell gravel without *Ostrea*. Bottom not observed. Sample from depth of 3 dm.

At this place the lower bed will be considered. The material contains relatively little mineral matter, the finest being sand.

The fauna is composed of 6 ax-forms, 12 a^lx-forms, 10 bx-forms, 4 b^mx-forms, and 7 b^lx-forms. It is comparable to modern faunas. In bathymetrical respect it is composed of 7 s-forms, 24 sd-forms, and 8 d-forms. The last group is represented by few individuals. The bed may have been accumulated in shallow water or at the shore. As the bed must be essentially older than the overlying Ostrea gravel, which probably dates from the last uplift, it probably derives from the high stand of land preceding the Tapes submergence.

Röd.

Table p. 653.

1.5 km S of Fiskebäckskil, 300 m NW of the crossroads at Grönskhult, about 11 m above sea level, 1917 and 1919.

The shell bed occurs in a widening of a glen on ground sloping gently towards the east. The nearest rock ledge lies 40 m to the south and rises 5 m above the bed. The bed has a very large extent. It presents the following section:

Topmost, 0.2 m mold with shells.
0.9 m shell gravel. The upper half consists largely of shells (sample 3), the lower half of shells, pebbles, and sand (sample 2).
0.2 m fine sand with scattered shells.
0.8 m shell gravel. The upper 0.2 m rich in pebbles and in large shells of *Mytilus modiolus*, *Pecten islandicus*, *Saxicava*, and *Balanus porcatus*. The lower part consists of small shells and sand (sample 1).
Shell-free sand.

The composition of the fauna is 18 ax-forms, 12 a^lx-forms, 7 bx-forms, 4 b^mx-forms, and 3 b^lx-forms. Some of the arctic species, as *Portlandia arctica*, evidently occur in secondary position. The most southerly species are *Coecum glabrum*, now extending northward to the Boknfjorden and Oslofjorden, and *Hinnites pusio* and *Tellina crassa*, distributed up to the Trondhjemsfjorden.

Bathymetrically the composition is 6 s-forms, 15 sd-forms, and 23 d-forms. The last-mentioned are represented by single individuals and consist to a great part of arctic forms probably occurring in secondary position. The most common shells are such of *Balanus crenatus* and *Mytilus edulis*. The nature of the deposit indicates that the whole of it was formed in very shallow water or in the shore line.

Judging from the fauna the lower strata of the bed may be derived from the latter part of the Ancylus age, but the growth has perhaps gone on with interruptions during various stages of the post-glacial epoch, judging from the different strata and the oscillations of level that have effected the region.

Fjällbacka II.

Table p. 656.

Fjällbacka, behind the drug store, about 10 m above sea level, 1917.

The bed is situated on the northern slope and at the foot of a hill which rises with a grade of about 25° to an altitude of 25 m above the shell deposit. An exposure showed the following layers:

Topmost, 0.3 m shore cobbles.
1.5 m shell gravel.
Sand.

The lowest strata of the bed are clayey. The upper and greater part of the bed contains fairly numerous pebbles.

The fauna is composed of 6 ax-forms, 7 a^lx-forms, 4 bx-forms, 4 b^mx-forms, and 5 b^lx-forms. The most southerly forms, which reach their northern limits in the Trondjemsfjorden and farther south, are *Bittium*, *Lepton*, *Nassa reticulata*, *Rissoa parva*, and *Tapes aureus*. Of these *Bittium* and *Rissoa* are well represented, suggesting that the temperature of the water was nearly or fully as high as at present.

Bathymetrically the fauna consists of 7 s-forms, 15 sd-forms, and 4 d-forms, among which the last-mentioned are represented by single or but few specimens. The most numerous species are *Balanus crenatus*, *Mytilus edulis*, and *Rissoa parva*. The upward increase of *Littorina* and of the coarseness of the material suggests deposition in diminishing water depth. The bed may have been formed in a depth of few meters largely of downwashed shells.

Sörgården.

Table p. 656.

17.5 km WNW of Göteborg, Björkö, the east coast at the head of the bay just S of Sörgården, 2 m above sea level, 1917.

The deposit consists of clayey shell gravel. It is overlain by shell-free clay 4 dm thick. The bed has been large but in 1917 had been largely removed. One sample has been analyzed. The washed gravel contains more pebbles and sand than shells.

The fauna consists of 5 ax-forms, 4 a^1x-forms, 5 bx-forms, and 2 b^1x-forms. The representatives of the last group are *Bittium* and *Lepton nitidum*, which now have their northern limits of distribution at Trondhjem and Bergen, respectively. The fauna resembles that in the beds from the last part of the Ancylus age. The clay may be derived from the Tapes age when the water was deeper.

With regard to the bathymetrical occurrence of the molluscs the fauna is divided in 3 s-forms, 10 sd-forms, and 3 d-forms. *Littorina* is fairly numerous, while the d-forms are poorly represented. The bed probably was formed in a few meters of depth.

Tången II.

Table p. 656.

See page 598. At this place the top sample will be treated. It consists of sandy gravel rich in shells.

The fauna consists of 6 ax-forms, 11 a^1x-forms, 13 bx-forms, 1 $b^{'''}$x-form, and 6 b^1x-forms. With the exception of *Bittium* all the b^1x-forms are poorly represented.

Bathymetrically the fauna is composed of 9 s-forms, 20 sd-forms, and 7 d-forms. The d-forms are few in individuals, and so is *Mytilus edulis*. *Littorina* and other species frequent in shallow water are most numerously represented. The shell gravel was formed when the water level stood slightly above the place.

Näset I.

Table p. 656.

13.5 km NNW of Lysekil, on the east side of the Klevekilen, 0.5 km N of the end of the peninsula, at the head of the little bay of the Klevekilen, about 5 m above sea level, 1917.

The shell deposit is extensive, covering the whole valley bottom. The exposure occurs at the foot of rock ledges which rise steeply some 25 m above the bed. It shows the following strata:

Topmost, 1 dm cobbles and gravel.
5 dm shell gravel with *Ostrea*. Sample 3 (p. 636).
(Sharp limit.)
5 dm shell gravel. Samples at bottom and at top.
Some clay and, below, bed rock.

Here the lower bed will be treated. Sample 1 is fairly stony, sample 2 is only somewhat stony.

The composition of the fauna is 5 ax-forms, 15 a^1x-forms, 15 bx-forms, 5 b^mx-forms, and 8 b^1x-forms. Several of the molluscs reach their northern limits on the wert coast of Norway. The temperature of the water must have been as high as at present.

Bathymetrically the fauna is composed of 11 s-forms, 29 sd-forms, and 8 d-forms. The last group plays a very subordinate rôle. *Mytilus*, *Littorina*, *Lacuna*, and other species preferring very shallow water are well represented. The bed was clearly formed in shallow water or at the shore, not in deep water; for, though the s-forms could be washed down, the d-forms then would be much more numerous. The change in frequency of the most typical species does not indicate whether decrease or increase of the water depth took place during the time of formation. *Mytilus* decreases, *Littorina* and *Lacuna* increase in numbers upward. As this shell bed is with a break overlain by another bed probably dating from the last upheaval, it may be derived from the transition between Ancylus and Littorina time. It seems to show that the shore line receded to 10 or less meters above the modern stand.

Ellene.

Table p. 657.

2 km SSW of Bovallstrand, 300 m SSW of the head of the bay W of Ellene, about 4.5 m above sea level, 1917.

The bed is situated W of the road at the foot of a hill which rises steeply some 30 m. It is large and 2.2 m thick. It is exposed in a long pit. Samples were taken at the bottom, 1 and 1.6 m above the bottom and at the surface. The material is fairly stony, especially in the second sample, and somewhat clayey throughout.

At the bottom the fauna is composed of *Balanus crenatus*, *Littorina*, *Mytilus*, and *Verruca*, i. e. of forms extending as far as the eastern part of the Murman Coast and farther. In sample no. 2

the number of the species is 12. The warmest forms, *Mangelia costata* and *Rissoa parva*, reach their northern limit on the Norwegian west coast and in the Oslofjorden. In samples 3 and 4 the fauna is very rich. The fauna of the whole bed consists of 6 ax-forms, 13 a^lx-forms, 15 bx-forms, 7 b^mx-forms, and 9 b^lx-forms. The bottom strata may be of late-glacial or early post-glacial age, and the middle strata of late Ancylus age. The upper strata date perhaps from late Littorina time. As no part was formed in deep water, the formation can hardly have gone on without interruption in spite of the fact that the shell gravel shows no traces of a break in the deposition.

Bathymetrically the composition of the fauna is 10 s-forms, 27 sd-forms, and 13 d-forms. The d-forms are relatively poorly represented, while *Rissoa parva*, *Balanus crenatus*, *Verruca*, and *Mytilus* aro most numerous. Thus, no part of the bed was formed in deep water by downwashing of shells or otherwise. The variations in frequency of the most typical species is contradictory. *Mytilus* has a small maximum in sample 2 and decreases upward; *Littorina* and *Lacuna* increase upward to maxima at the top. The percentage of pebbles is largest in sample 2. Consequently the changes of level during the time of formation cannot be definitely determined. The different parts of the deposit may have been formed in water that was at most a few meters deep.

Beds from the Tapes sinking.

Hovenäs III.

Table p. 657.

5.5 km S of Hunnebostrand, at the head of the western branch of the Örnefjorden, at the mouth of the brook, 1.5 m above sea level, 1917.

The bed is situated in a valley 40 to 50 m wide. On the west side rocks rise rather steeply about 10 m above the bed; while on the east side they rise gently somewhat higher. A section shows the following strata:

Topmost, 2.5 dm coarse gravel.
1.5 dm gravel rich in shells. Sample 3 (p. 642).
1.2 dm clay.
3 dm fine shelly gravel. Sample 2.
2.5 dm Ostrea gravel. Sample 1.
Sandy, shell-free gravel.

The lower shell bed, subjacent to the clay, will be treated at this place. Sample 1 contains a fair amount of mineral gravel but no clay. It has large shells of *Cardium echinatum*, *Cyprina*, *Ostrea*, *Mya truncata*, and other species. The fauna is composed of 4 ax-forms, 6 a^{l}x-forms, 8 bx-forms, 1 b^{m}x-form, and 6 b^{l}x-forms. The water temperature may have been higher than at present. Bathymetrically the fauna contains 4 s-forms, 15 sd-forms, and 6 d-forms. All the species, and notably the s-forms, have few individuals. The oysters apparently lived on the rock walls. The bed probably was deposited in water at least 5 m deep.

Sample 2 consists of fine, clay-free mineral gravel with shells. It has a fauna of the compositions 6 ax-forms, 3 a^{l}x-forms, 7 bx-forms, 3 b^{m}x-forms, and 4 b^{l}x-forms; and 4 s-forms, 13 sd-forms, and 6 d-forms. All species are poorly represented as regards individuals. This layer may also have been formed in a depth of several meters. The conditions do not seem to indicate whether the deposition took place during transgression or regression or whether the superjacent clay was formed in deep water or in shallow water; but the lower shell bed probably dates from the earliest Littorina time, the clay from the transgression maximum, and the top beds from the last regression.

Slottet II.

Table p. 657.

6.5 km S of Fjällbacka, 300 m E of the Hombergssund, Slottet, on the southern side of the road, about 16 m above sea level, 1917.

The shell bed is situated at the northern foot of a rock ledge which rises steeply 10 m. Otherwise the ground is level. The deposit is more than 1.5 m thick; the substratum was not reached. Samples were taken at depths of 1.5 and 0.75 m and at the top. The material is relatively fine-grained and contains little mineral matter, the finest being silt.

The fauna contains 61 species divided into 11 ax-forms, 14 a^{l}x-forms, 19 bx-forms, 8 b^{m}x-forms, and 9 b^{l}x-forms. It is comparable to faunas of modern beds. Bathymetrically it is composed of 9 s-forms, 29 sd-forms, and 23 d-forms. The species of the last group are represented by far fewer individuals than are the s-forms. *Mytilus edulis*, especially if fragments are taken into account, forms a much greater part of the lowest sample than of the topmost one. *Littorina* also decreases in number upwards. Although the testimony is not unanimous, it seems likely that the bed was deposited during sinking of land, during the Tapes sinking.

Tången I.

Table p. 657.

2 km NNE of Mollösund, just E of the road and near the Tångesund, about 20 m above sea level, 1917.

The bed occurs in a depression with rock ledges rising on three sides about 3 m above it. It was originally rather extensive but has been largely removed. The thickness is probably little over 1.6 m. Samples were taken at depths of 1.6 and 0.8 m and at the top. The material is rather stony throughout.

The fauna is composed of 10 ax-forms, 15 a^{1}x-forms, 14 bx-forms, 2 b^{III}x-forms, and 7 b^{1}x-forms. At least part of the arctic species may be derived from an older deposit torn up by the waves. Bathymetrically the fauna consists of 11 s-forms, 23 sd-forms, and 14 d-forms. *Balanus crenatus*, represented by relatively small shells, plays by far the greatest rôle. *Mytilus edulis* comes next in importance. *Littorina* is fairly numerous. The d-forms that can be assumed to have lived during the time of formation of the bed are rather poorly represented. Thus, the whole bed may have been formed in rather shallow water. The changes of the fauna in vertical direction do not indicate whether deposition took place during regression or transgression. The time of formation may have practically coincided with the climax of the transgression.

Udden II.

Table p. 657.

5 km S of Fjällbacka, 2 km SSE of the northern end of the Hombergssund, at Udden, 25 m NE of Udden I (p. 605), on the northern side of the road, some 27 m above sea level, 1917.

The present bed either rests on the bed Udden I, though lying at a lower level, or is part of the same bed. The bed is large. It presents the following section:

Topmost, 0.05 m Ostrea gravel (p. 619).
0.4 m shell-free clay with sharp contacts.
3 m shell gravel.
Clay with *Mytilus edulis*.

At this place the lower bed will be considered. Sample 1 is strongly clayey, and sample 2 is somewhat clayey; the others have fine sand as the finest material. Sample 3 is very stony, the other samples fairly so. The lowest sample is clayey *Mytilus* gravel. It has a fauna of the composition 4 ax-forms, 9 a^{l}x-forms, 2 bx-forms, and 2 b^{l}x-forms. The species of the last group *Bittium* and *Rissoa parva*, are represented by single individuals. The warm species undergo a gradual increase in numbers toward the top of the deposit. The fauna of the whole bed contains 7 ax-forms, 12 a^{l}x-forms, 13 bx-forms, 8 b^{m}x-forms, 7 b^{l}xforms, and 1 l-form. *Psammobia vespertina*, occurring 0.5 below the top, suggests warmer water during the formation of the upper part of the bed than prevails at present.

Bathymetrically the composition of the fauna is 10 s-forms, 25 sd-forms, and 13 d-forms. The last-mentioned group plays a subordinate rôle. The percentage of the d-forms increases upward. *Littorina* has a small maximum in sample 2. *Mytilus* has perhaps a maximum in sample 1, as this to a great part consists of *Mytilus* fragments. The bed may have been formed in water that was at most a few meters deep, and at least the upper part during transgression, the Tapes transgression. The superjacent clay may be derived from the climax of this submergence, and the Ostrea gravel from the last land upheaval (p. 533).

Solbräcke.

Table p. 657.

2.5 km N of Bovallstrand, 0.5 km S of Svenneby Church, on the east side of the highway, about 24 m above sea level, 1917.

The bed occurs in a depression whose edges rise about 5 m above it. It is 0.5 m thick. It rests on till and is overlain by sand 0.3 m thick. Samples were taken at bottom and top. The material contains a fair amount of mineral gravel and sand.

The fauna contains 6 ax-forms, 15 a^{l}x-forms, 17 bx forms, 6 b^{m}x-forms, and 7 b^{l}x-forms. As regards the depths at which the molluscs live, it is divided into 12 s-forms, 26 sd-forms, and 13 d-forms. *Mytilus*, *Littorina*, *Lacuna*, and other species living at or near the shore are numerous, whereas the d-forms are poorly represented. The bed may have been formed in water somewhat more than 5 m deep, when the edges of the depression were still below the water level. The capping sand may date from the last passing of the shore line. Because of the situation of the bed the d-forms that are present cannot have been washed up. Most of them may have lived on the spot in a depth of 5 m, others are perhaps redeposited from an older deposit. The bed may date approximately from the climax of the post-glacial transgression.

Beds from the last uplift.

Kårehogen.

Table p. 658.

11 km SSE of Lysekil, 1 km SSE of Morlanda Church, altitude unknown but probably between 25 and 35 m, 1917.

The bed rests against a rock ledge that rises steeply some 15 m. It may be of large extent. It is partly forested, partly cultivated. Its thickness is in excess of 1.5 m. The two topmost decimeters consist of shelly mineral gravel in which sample 3 was taken. Other samples were obtained at depths of 1.5 m and 0.75 m. The two lower samples contain relatively little mineral matter.

The fauna of the two lower samples is composed of 7 ax-forms, 11 a^1x-forms, 7 bx-forms, 2 b^{m}x-forms, and 8 b^1x-forms. The last group includes *Lepton nitidum*, *Mangelia costata*, *Tapes aureus*, and others that reach their northern limits on the Norwegian west coast and in the Oslofjorden. Bathymetrically this fauna consists of 7 s-forms, 20 sd-forms, and 8 d-forms. The bed probably was deposited in a depth of a few meters and during regression, as is suggested by the upward increase of s-forms and decrease of d-forms.

The shelly top gravel has a fauna of the composition 8 ax-forms, 8 a^1x-forms, 2 bx-forms, 1 b^{m}x-form, and 5 b^1x-forms; and bathymetrically of 6 s-forms, 13 sd-forms, and 5 d-forms. Some large *Saxicava* shells and probably other shells are redeposited from a glacial bed. This gravel may be a shore deposit, formed as the shore line passed during the last uplift of the land.

Fjällbacka I.

Table p. 658.

1 km SSE of Fjällbacka Church, 125 m S of the bed »Fjällbacka» described in an earlier paper (ANTEVS, 1917, p. 276), about 33 m above sea level, 1917.

The bed is situated on fairly level land. To the west, at a distance of 60 m, rock ledges rise about 8 m above the deposit; and to the southwest, at a distance of 40 m, ledges rise 5 to 6 m. The bed is 4 dm thick and is underlain by pure sand. The material is mineral gravel and sand with shells, among which oyster shells are prominent.

The fauna consists of 1 ax-form, 9 a^{l}x-forms, 11 bx-forms, 4 b^{m}x-forms, and 6 b^{l}x forms; and bathymetrically of 6 s-forms, 20 sd-forms, and 5 d-forms. The littoral species are poorly represented. The bed may have been laid down in water a few meters deep at a time of somewhat higher water temperature than at present. It probably dates from the early part of the last rise.

Udden II.

Table p. 658.

See page 616. At this place the capping oyster gravel will be considered. The material contains a fair quantity of mineral gravel but no clay. It is rich in fragments of oyster shells. The fauna is composed of 4 ax-forms, 9 a^{l}x-forms, 8 bx-forms, 3 b^{m}x-forms, 10 b^{l}x-forms, and 1 l-form — *Tapes decussatus.* With respect to the depths preferred by the molluscs the fauna is divided on 9 s-forms, 18 sd-forms, and 8 d-forms. The last group is poorly represented as regards individuals. The bed may have been deposited in a water depth of a few meters during the last regression.

Fiskebäckskil I.

Table p. 658.

250 m W of Fiskebäckskil Church, about 22 m above sea level, 1917, 1919.

The deposit is situated in an east-west pass between rock ledges that rise 6 to 8 m above it. It occurs just to the west of the pass point, at whose very crest shell free gravel is to be found. The material consists of mineral gravel with shells among which oyster shells are particularly prominent. In pickings made in 1904, probably by Mr. Adolf d'Ailly, and presented to the writer by the Kristineberg Zoölogical Station, the following species were found besides such as occurred in the statistical sample:

Anomia ephippium
» *patelliformis*
Aporrhais pes pelicani
Astarte elliptica
» *montagui*
Balanus crenatus
» *porcatus*

Cardium edule
» *fasciatum*
Clathurella linearis
Cyprina islandica
Dentalium entale
Hinnites pusio
Leda minuta

Lepeta cocca
Lepidopleurus asellus
Lucina borealis
Macoma baltica
» *calcaria*
Mactra subtruncata
Montacuta bidentata
Mya truncata
Mytilus modiolus
Nucula nucleus
» *sulcata*
Panopaea norvegica
Patella vulgata
Pecten islandicus
» *tigrinus*
Solen ensis
Tapes decussatus
» *pullastra*
Tectura virginea
Turbonilla indistincta
Verruca stroemia

The fauna is composed of 69 species divided into 10 ax-forms, 17 a^{l}x-forms, 24 bx-forms, 6 b^{m}x-forms, 11 b^{l}x-forms, and 1 l-form — *Tapes decussatus*, now first met as a relict on the Norwegian west coast. Bathymetrically it consists of 13 s-forms, 28 sd-forms, and 28 d-forms. This fauna is rather heterogeneous. Some shells of *Saxicava* are large and thick, redeposited from a glacial deposit. Several other shells may occur in secondary position, having originally been laid down in much deeper water than the present shell bed. Judging from the consistency of the material and the mode of occurrence, the bed was formed in very shallow water and at the shore, most probably during the last land upheaval.

Fuglevik.

Table p. 658.

2.5 km S of Fredrikstad, 300 m W of the bay and 500 m SW of Fuglevik, on both sides of the highway, about 35 m above sea level, 1917.

The bed is situated at the eastern foot of rock ledges that are a few meters high at that point but at a distance of 50 m much higher. It is large, extending from southeast to northwest. Its thickness is more than 3.5 m; the bottom was not reached. It is overlain by a layer of shell-free gravel a few decimeters thick. Samples were taken at depths of 3.5, 2.5, 1.5, and 0.5 m, and at the top. Samples 1 and 2 contain little mineral matter, samples 3 and 4 a good deal; while sample 5 contains more sand and gravel than shells.

The fauna consists of 60 species divided into 7 ax-forms, 18 a^{l}x-forms, 19 bx-forms, 6 b^{m}x-forms, 9 b^{l}x-forms, and 1 l-form — *Tapes decussatus*, showing that at least during the deposition of the middle and upper parts the water temperature was higher than at present. Bathymetrically the fauna contains 14 s-forms, 27 sd-forms, and 19 d-forms. *Mytilus*, *Littorina*, *Lacuna*, and other s-forms are numerously represented. Their upward decrease may be due to the growing percentage of mineral gravel. The d-forms are rather poorly represented. The bed may have been accumulated during regression, the last uplift. The lower part may have been deposited in water that was several meters deep and the upper part near the shore. The capping shell-free gravel may mark the last passing of the shore line.

Dal.

Table p. 658.

5 km ESE of Fredrikstad, 600 m E of the crossroads at Dal, about 34 m above sea level, 1917.

The bed occurs at the eastern foot of a rock that rises some 7 m above it. It is large and 1.5 m thick. It rests on sand and is overlain by a layer of sand 2 dm thick. Samples were taken at bottom, 0.5 and 1 m above bottom, and at top. The material contains relatively little mineral matter but a large quantity of shell fragments.

The fauna contains 7 ax-forms, 13 $a^{l}x$-forms, 17 bx-forms, 4 $b^{m}x$-forms, and 10 $b^{l}x$-forms and is comparable to faunas in modern shell beds. With respect to the depths at which the animals preferably live it is divided into 7 s-forms, 27 sd-forms, and 17 d-forms. Among the s-forms *Mytilus edulis* is especially numerous. The bed may have been formed in a water depth of several to a few meters and during the last regression. The capping sand may derive from the last passing of the shore line.

Fjelle.

Table p. 658.

5 km WSW of Fredrikstad, 0.8 km N of the Fjellskilen, 300 m SE of the crossroads at Fjelle, about 28 m above sea level, 1917.

The deposit occurs in a glen or cleft about 30 m wide. It covers the entire bottom, which slopes moderately towards the southwest. The rock walls rise 10 to 20 m above the spot where the samples were taken. These were obtained at a depth of 1 m and at the surface. The substratum was not reached. The material contains some clay.

The lower sample has only 19 species; the top sample has 37.

Both together have 39 forms. The fauna of sample 1 contains 2 ax-forms, 7 a^{1}x-forms, 6 bx-forms, 1 b^{m}x-form, and 3 b^{1}x-forms — *Bittium*, *Nassa reticulata*, and *Odostomia rissoides*. Of these the last-mentioned is distributed as far as Bergen, the other two as far as the Trondhjemsfjorden. Bathymetrically the fauna is composed of 5 s-forms, 10 sd-forms, and 4 d-forms.

The fauna of sample 2 contains 6 ax-forms, 11 a^{1}x-forms, 9 bx-forms, 3 b^{m}x-forms, and 8 b^{1}x-forms. It has several species that reach their northern limits on the west coast of Norway. It is fully as warm as the faunas of modern beds. Its bathymetrical composition is 6 s-forms, 22 sd-forms, and 9 d-forms. *Mytilus edulis*, *Littorina*, *Lacuna*, and *Rissoa interrupta* predominate throughout the bed. These and other species have perhaps lived on the rocks, and the bed was perhaps deposited in water of several meters depth.

Fjällbacka III.

Table p. 659.

0.8 km SSE of Fjällbacka, about 15 m above sea level, 1917.

The bed is situated at the foot of a rock ledge that rises steeply 19 to 20 m. It has been partly removed. It is 3 m thick and is underlain by till. Samples were taken at bottom, 1 and 2 m above bottom, and at top. The lowest sample contains about as much mineral gravel and sand as shells, the top sample a fair amount of mineral matter, and samples 2 and 3 little. Sample 3, especially, is rich in fragments of *Corallina officinalis*, a calcareous alga living inside the depth curve of 10 m. The transition to the top of the deposit, which is a typical oyster bed, is gradual, so that no break in the sedimentation may have taken place.

The fauna contains 60 species divided into 9 ax-forms, 11 a^{1}x-forms, 22 bx-forms, 9 b^{m}x-forms, and 9 b^{1}x-forms. It indicates at least as warm water as at present. Bathymetrically it comprises 10 s-forms, 32 sd-forms, and 18 d-forms. The last-mentioned play a subordinate rôle. No part of the bed may have been formed in water over 15 m deep. The frequency maxima of *Mytilus edulis*, *Lacuna divaricata*, *Onoba striata*, etc. in the middle of the bed may largely be due to the small content of mineral gravel here. The whole bed may have been formed during regression, during the last land upheaval.

Fintorp II.

Table p. 659.

0.7 km. S of Bovallstrand, about 17 m above sea level, 1917. The bed occurs in a valley running north and south. In the northwest, at a distance of 20 m, rock ledges rise steeply about 10 m above the bed. In the east, at a distance of 60 m, rocks rise at least 50 m. The shell deposit is 1 m thick, underlain by sand, and overlain by a thin layer of pure sand. Samples were taken at bottom, middle, and top. The lowest sample contains little mineral matter, the two upper ones a fair amount. Besides species encountered in the statistical samples the following were observed: *Aporrhais pes pelicani*, *Astarte elliptica*, *A. montagui*, *Lucina borealis*, *Patella vulgata*, and *Portlandia arctica*. *Portlandia*, at least, occurs in secondary position.

The fauna is composed of 7 ax-forms, 14 $\mathrm{a^lx}$-forms, 12 bx-forms, 8 $\mathrm{b^mx}$-forms, 9 $\mathrm{b^lx}$-forms, and 2 l-forms. *Tapes decussatus* and *Psammobia vespertina* are now extinct on the Swedish west coast and first met in the warmer waters of the Norwegian west coast where they remain as relicts.

Bathymetrically the composition is 14 s-forms, 29 sd-forms, and 9 d-forms. The d-forms are poorly represented in comparison to the littoral species. The bed resembles modern littoral shell deposits and may have been formed just below or in the water line. The warm fauna suggests that it is derived from the last upheaval. The bed lies at about 42 per cent of the Tapes limit.

Fossa.

Table p. 659.

See page 610. Here the upper bed, the Ostrea gravel, will be considered. The material contains only little mineral gravel. The fauna is composed of 6 ax-forms, 11 $\mathrm{a^lx}$-forms, 13 bx-forms, 5 $\mathrm{b^mx}$-forms, and 8 $\mathrm{b^lx}$-forms; and bathymetrically of 6 s-forms, 27 sd-forms, and 10 d-forms. The heavy oyster shells may have dropped from the rock walls against which the bed rests. The deposit may have been laid down in water that was a few meters deep. It no doubt dates from the last uplift.

Hestrand II.

Table p. 659.

9.5 km S of Fjällbacka, 1 km NNW of Hestrand, 200 m N of Hestrand I, about 15 m above sea level, 1917.

The bed occurs in the same flat valley as Hestrand I; in fact, both beds probably form parts of the same large deposit covering the whole valley. About 25 m north of the present exposure rock ledges rise steeply 10 to 12 m above the valley bottom; and 50 m west of the bed, 8 to 10 m. The deposit is more than 2 m thick; the bottom was not reached. Samples were taken at depths of 2 and 1 m aud at the top. The two lower samples contain little mineral matter but a considerable quantity of fragments of *Corallina officinalis*. The top sample contains a great deal of gravel and sand. There is no finer material than fine sand. Besides forms found in the statistic sample, *Astarte elliptica*, *Mactra subtruncata*, and *Tapes decussatus* were observed. Some shells of *Saxicava* are large and heavy, late-glacial.

The fauna consists of as many as 67 species divided into 8 ax-forms, 16 a^lx-forms, 21 bx-forms, 6 b^mx-forms, 14 b^lx-forms, and 2 l-forms. The species of the last group are *Tapes decussatus* and *Psammobia vespertina*. The fauna suggests higher water temperature than at present.

With respect to the depths preferred by the molluscs the fauna consists of 16 s-forms, 32 sd-forms, and 19 d-forms. The s-forms are present in much greater numbers of individuals than are the d-forms. This fact together with the nature of the material shows that no part of the bed was deposited in deep water. The upward increase of *Littorina* and *Lacuna* and of the percentage of mineral gravel may suggest deposition in water of decreasing depth. Accordingly, the bulk of the bed may have been formed in shallow water and the top layers at the shore line. The bed may be derived from the last rise of the land. It lies at about 38 per cent of the Tapes limit.

Hamn I.

Table p. 659.

6 km S of Fjällbacka, halfway between Hamn and the Hombergssund, just E of the road, about 10 m above sea level, 1917.

The deposit occurs on a rather steep westward slope. A little to the east rock ledges rise 20 to 30 m above the deposit. This consists of sand rich in shells. One sample has been analyzed.

The fauna is composed of 13 ax-forms, 13 $a^{l}x$-forms, 11 bx-forms, 4 $b^{m}x$-forms, and 5 $b^{l}x$-forms. The great number of arctic species makes it probable that a late-glacial deposit has been reworked by the waves and mixed with the post-glacial shells. Bathymetrically the fauna comprises 6 s-forms, 20 sd-forms, and 20 d-forms. The high percentage of d-forms is partly due to the probably redeposited arctic species. The bed was propably formed in a water depth of several meters during the last regression.

Kristineberg I.

Table p. 659.

1 km W of Fiskebäckskil, 100 m S of Kristineberg Zoölogical Station, about 10 m above sea level, 1917.

The shell bed is situated on the northward slope of a rock ledge that rises a few meters. In 1917 there was but a remnant. This was 0.6 m thick, was underlain by bed rock, and covered by mold a few decimeters thick. Samples were taken at bottom and top. The material contains but little mineral matter, the finest being sand. It consists predominently of *Mytilus edulis* and *Balanus crenatus*. Single shells of *Saxicava* are large, redeposited from a late-glacial bed. So are probably also other shells. In a picking made by Mr. ADOLF D'AILLY in 1904 and presented to the writer by the Kristineberg Zoölogical Station the following species not occurring in the statistical sample are represented:

Aporrhais pes pelicani
Balanus hameri
Buccinum undatum
Cardium echinatum
» *edule*
Cyprina islandica
Hinnites pusio
Lucina borealis
Macoma baltica
» *calcaria*
Mya truncata
Ostrea edulis
Panopaea norvegica
Patella vulgata
Pecten islandicus
Solen siliqua
Tapes aureus
» *virgineus*

The composition of the fauna is 12 ax-forms, 17 $a^{l}x$-forms, 18 bx-forms, 5 $b^{m}x$-forms, and 10 $b^{l}x$-forms; and bathymetrically 11 s-forms, 29 sd-forms, and 22 d-forms. The shells may be partly derived from a late-glacial deposit torn up be the waves. The bed may have been accumulated in shallow water or possibly at the shore during the last rise of the land.

Hovenäs I.

Table p. 659.

14.5 km NNW of Lysekil, 4.3 km NNE of Gravarne, 0.7 km S of Hovenäs, on the road, about 14 m above sea level, 1917.

The bed is situated on a rock plateau that is level except for a low ledge just west of it. It is of insignificant thickness. One sample has been analyzed. The material contains a fair amount of fine mineral gravel and consists to a great part of fragments of oyster shells.

The fauna comprises 2 ax-forms, 8 a^{l}x-forms, 7 bx-forms, 3 b^{m}x-forms, and 6 b^{l}x-forms; and bathymetrically 6 s-forms, 16 sd-forms, and 4 d-forms. The bed may have been deposited near and at the shore during the last rise of the land.

Hovenäs II.

Table p. 659.

15 km NNW of Lysekil, 4.5 km NNE of Gravarne, 0.4 km S of Hovenäs, 300 m N of Hovenäs I, about 13 m above sea level, 1917.

The deposit occurs in an insignificant depression in a plateau, that is level except for a low rock ledge in the south. It is 0.75 m thick. It is underlain by sand, which gradually grows shelly, and is overlain by a layer of shell-free sand 1.5 dm thick. Samples were taken near the bottom and the top. Both samples, and especially the lower one, contain a fair amount of mineral gravel and sand and some fragments of *Corallina officinalis*. *Cyprina islandica*, *Lucina borealis*, and *Solen ensis* were found in addition to forms represented in the statistic sample.

The fauna is composed of 5 ax-forms, 13 a^{l}x-forms, 13 bx-forms, 7 b^{m}x-forms, and 8 b^{l}x-forms; and, with respect to the bathymetrical distribution, of 6 s-forms, 27 sd-forms, and 15 d-forms. It is comparable to modern faunas in the region. The whole fauna cannot well have lived on the spot at the same time, and the situation of the bed on a level plateau excludes both downwashing and upwashing worth mentioning, so that part of the shells probably are derived from an older deposit laid down in fairly deep water. and the present bed was probably deposited in insignificant depth during the last uplift.

Klevekilen I A.

Table p. 660.

See page 609. At this place the bed above the clay will be treated.

The material contains scattered pebbles and no clay. The fauna is formed of 5 ax-forms, 11 a^{l}x-forms, 10 bx-forms, 4 b^{m}x-forms, and 4 b^{l}x-forms and is thus distinctly colder than that of the lower bed, though not colder than the faunas of some modern shell deposits. Bathymetrically the composition is 10 s-forms, 20 sd-forms, and 5 d-forms. The bed was probably formed by upwashing during the last rise of the land (see p. 609).

Fintorp I.

Table p. 660.

1 km S of Bovallstrand, just N of the head of the innermost northward branch of the Vikekilen, on the western side of the valley, about 8 m above the sea, 1917.

The deposit is situated in a little half-circular reëntrant in the north-south rock wall which rises from 10 to 20 m above the bed. In the innermost part of the reëntrant is an accumulation of cobbles. The shell deposit is 0.75 m thick. It is underlain by shelly postglacial clay of unknown thickness. Samples were taken of the clay and from the lower and upper parts of the bed. The clay contains fairly numerous pebbles, the shell gravel a moderate upward-decreasing quantity of mineral matter.

In the clay a fauna of 33 species has been determined divided into 3 ax-forms, 10 a^{l}x-forms, 11 bx-forms, 4 b^{m}x-forms, and 5 b^{l}x-forms. The water temperature may have been at least as high as today. Bathymetrically the fauna contains 4 s-forms, 21 sd-forms, and 8 d-forms. This fauna does not indicate very deep water; but, everything considered, the clay may have been deposited in relatively open water and at a depth of several meters (see p. 534).

The fauna of the shell gravel is composed of 4 ax-forms, 13 a^{l}x-forms, 14 bx-forms, 3 b^{m}x-forms, and 10 b^{l}x-forms and is thus fully as warm as those of the modern shell beds. In respect to the depths on which the molluscs preferably live, it is divided into 6 s-forms, 25 sd-forms, and 13 d-forms. *Mytilus edulis* is well represented and increases in number upwards. Also *Littorina* increases in the same direction. The lower part of the bed probably was deposited in water some 5 m deep, and the accumulation proceded during decrease of the water depth, during rise of the land

Svenneby V.

Table p. 660.

3 km NNV of Bovallstrand, on Valö, 300 m W of the bend of the long bay, between the farms, probably about 15 m above sea level, 1917.

The deposit occurs at the eastern foot of rock ledges which rise about 7 m. The thickness is unknown. One sample has been analyzed. The material consists in large part of fine mineral gravel.

The fauna is composed of 3 ax-forms, 13 $a^{l}x$-forms, 11 bx-forms, 3 $b^{m}x$-forms, and 6 $b^{l}x$-forms; and bathymetrically of 9 s-forms, 22 sd-forms, and 5 d-forms. Littoral molluscs are represented richly, d-forms by few or single individuals. The deposit in all respects resembles such as are now forming at the shore and may date from the last passing of the shore line.

Slottet I.

Table p. 660.

6 km S of Fjällbacka, 300 m E of the Hombergsfjärden, at Slottet, about 7 m above sea level, 1917.

The deposit is situated at the northeastern foot of a rock ledge rising some 15 m above it. The material consists of clayey and gravelly sand with shells, among which are large shells of *Ostrea*.

The fauna is composed of 9 ax-forms, 8 $a^{l}x$-forms, 10 bx-forms, 4 $b^{m}x$-forms, and 9 $b^{l}x$-forms; and bathymetrically of 4 s-forms, 26 sd-forms, and 12 d-forms. The s-forms are represented by few individuals only. *Portlandia arctica* is redeposited from an older bed, and so are probably several others. The bed may have been deposited in a water depth of several meters.

Hestrand I.

Table p. 660.

5 km NNW of Bovallstrand, 0.5 km NW of Hestrand, the neck of the little peninsula, about 12 m above sea level, 1917.

The deposit lies in a flat valley, which at the time of the formation of the shell gravel formed a bay. The distance to the rocks is in the east 40 m and in the west 75 m. An exposure showed:

Topmost, 1 dm pure sand.
3—4 dm fairly stony shell gravel.
Pure sand.

The fauna is composed of 4 ax-forms, 12 a^{l}x-forms, 13 bx-forms, 5 b^{m}x-forms, and 10 b^{l}x-forms and indicates at least as warm water as at present. Bathymetrically it is divided into 11 s-forms, 22 sd-forms, and 11 d-forms. The s-forms play a much greater rôle than do the d-forms, which are represented by single or few individuals. This fact, combined with the nature of the material and the stratigraphy, shows that the shell gravel was formed near the gently sloping shore, probably during the last uplift.

Näset II.

Table p. 660.

13 km NNW of Lysekil, 3 km NE of Gravarne, eastern shore of the Klevekilen, 300 m from the end of the peninsula, about 9 m above sea level, 1917.

The deposit occurs at the foot of low rock ledges. It was exposed in a well, and extent and thickness are therefore unknown. The material contains but little mineral matter. Large shells of *Ostrea* are prominent.

The fauna is composed of 5 ax-forms, 12 a^{l}x-forms, 14 bx-forms, 7 b^{m}x-forms, 9 b^{l}x-forms, and 1 l-form — *Psammobia vespertina*, which now is not found north or east of Bergen where it lives as a relict.

As regards the depths preferred by the fauna, this is formed of 9 s-forms, 24 sd-forms, and 14 d-forms. The bed may have been deposited in a water depth of a few meters during the last rise of the land.

Svenneby VII.

Table p. 660.

3 km N of Bovallstrand, 1.5 km due W of Svenneby Church, 200 m W of the bay, about 5 m above sea level, 1917.

The bed is situated in a little valley at the southern foot of a rock ledge that rises steeply about 5 m. The bed is rather large and is 1.2 m thick. It is underlain by till. Samples were taken at bottom, middle, and top. The two lower samples contain a large percentage of fine mineral gravel and sand, the top sample a moderate percentage. The two upper samples, besides, contain clayey silt. The deposit is a typical oyster bed with large oyster shells, especially at the top. *Mangelia brachystoma* was found in the two lower samples.

The fauna consists of 6 ax-forms, 10 a^lx-forms, 14 bx-forms, 10 b^mx-forms, and 13 b^lx-forms. It indicates warmer water than now washes Bohuslän. Bathymetrically the fauna is composed of 7 s-forms, 26 sd-forms, and 20 d-forms. Both s-forms and d-forms are on the whole poorly represented as regards individuals. The shells are largely of molluscs thriving equally well inside as outside the 10 meter curve. The oyster, which prefers hard substratum, may have lived on the rock wall rising above the bed. The deposit may have been formed at a depth of 5 to 10 m during the last rise.

Svenneby I.

Table p. 660.

2.5 km NNW of Bovallstrand, 1.5 km WSW of Svenneby Church, Valö, at the base of the little peninsula extending eastward, about 8 m above the sea, 1917.

The deposit is situated in a valley, at the eastern foot of rock ledges rising 4 m above it and at some distance rising 6 m still higher. It consists of shelly sand and is 1 m thick. It is underlain by pure sand and covered by some mineral gravel. Samples were taken at the base and at the top.

The fauna contains 7 ax-forms, 12 a^lx-forms, 15 bx-forms, 4 b^mx-forms, and 9 b^lx-forms. Four species now reach their northern limits in the Bergen region. The water temperature was at least as high as at present. Bathymetrically the fauna is composed of 6 s-forms, 23 sd-forms, and 18 d-forms. *Mytilus* and *Lacuna* are well represented and, together with the nature of the material, suggest formation on shallow water. However, the number of the d-forms is so great that all of them can hardly be assumed to have been washed up. It is therefore probable that these latter partly occur in secondary position and that the formation of the deposit in its present condition took place in a few meters of depth during the last rise.

Svenneby VI.

Table p. 660.

3.5 km N of Bovallstrand, 1.3 km NW of Svenneby Church, on the west side of the long bay near its head, on the road, about 8 m above sea level, 1917.

The shell bed is situated in a narrow pass between steep rock walls that on the western side rise 5 to 6 m and on the eastern side about 10 m. It is 1.6 m thick and is underlain by till. Samples were taken at bottom, middle, and top. The material contains much mineral matter in form of gravel, sand, and clay. Large shells of *Ostrea* are prominent.

The fauna consists of 59 species, divided into 7 ax-forms, 15 a^{l}x-forms, 17 bx-forms, 7 b^{m}x-forms, and 13 b^{l}x-forms. The numerous oyster shells, especially, suggest that the temperature was somewhat higher than at present and that the deposit dates from the last rise. Bathymetrically the fauna is composed of 10 s-forms, 30 sd-forms, and 19 d-forms. The s-forms are present in relatively few individuals. The bed may have been deposited at a depth of a few meters, when the glen formed a sound.

Vik I.

Table p. 661.

1 km S of Bovallstrand, the southern part of the wedge-shaped peninsula, 50 m from the sea, about 11 m above sea level, 1917.

The deposit occurs in a valley whose bottom rises gently landward. The bordering rocks are low and may not have directly influenced the shell accumulation. The deposit consists of coarse mineral gravel and cobbles with shells. It is of littoral origin.

The fauna is composed of 3 ax-forms, 7 a^{l}x-forms, 5 bx-forms, 1 b^{m}x-form, and 6 b^{l}x-forms and, bathymetrically, of 6 s-forms, 13 sd-forms, and 3 d-forms.

Varpet.

Table p. 661.

10 km W of Fredrikshall, 2 km NNW of Sponviken, northwestern head of the Svalerödkilen, 200 m from the shore, at Varpet, about 20 m above sea level, 1917.

The bed is situated at the eastern foot of a rock wall 6 m high. Its extent is considerable. Its thickness is unknown but is more than 1 m. Samples were taken at a depth of 1 m and at top. The material contains but little mineral matter.

The fauna is composed of 7 ax-forms, 12 a^{l}x-forms, 20 bx-forms, 5 b^{m}x-forms, and 11 b^{l}x-forms and, bathymetrically, of 8 s-forms, 30 sd-forms, and 17 d-forms. It suggests a water temperature as at present. *Littorina*, *Mytilus*, and other s-forms are well represented; the d-forms are less numerously or poorly represented by individuals. The shells of the former may in part have been washed down from the rock ledge, and the bed may have been deposited at a water depth of some 5 m during the last rise of the land.

Lökken.

Table p. 661.

7 km SW of Fredrikstad, 1 km W of the Fjellskilen, 0.5 km S of the crossroads at Lökken, on the road, about 17 m above the sea. 1917.

The deposit occurs in a terrain that is for the most part level. It consists of clayey and stony shell gravel. The fauna is composed of 7 ax-forms, 13 a^{l}x-forms, 22 bx-forms, 5 b^{m}x-forms, and 7 b^{l}x-forms and, bathymetrically, of 9 s-forms, 24 sd-forms, and 21 d-forms. It suggests a water temperature like today's. The bed may have been deposited in a water depth of about 10 m and probably during the last land upheaval.

Ålestranden.

Table p. 661.

3.5 km W of Fredrikstad, 400 m W of the bay and Ålestranden, just W of the crossroads, about 16 m above sea level, 1917.

The deposit occurs at the eastern foot of a rock ledge that rises rather steeply some 15 m. It consists of shell-bearing stony clay. The fauna is composed of 4 ax-forms, 8 a^{l}x-forms, 12 bx-forms, 1 b^{m}x-form, and 9 b^{l}x-forms. Several species now reach their northern limits on the Norwegian west coast and in the Oslofjorden. Bathymetrically the fauna is divided into 6 s-forms, 20 sd-forms, and 8 d-forms. The sd-forms are also represented by the most individuals. The litteral species may be downwashed. All considered, the bed probably was deposited when the water level stood some 10 m above it during the last land upheaval.

Groten I.

Table p. 661.

10.5 km SE of Fredrikstad, the east side of the Tosekilen, in lat. 59° 10′, about 20 m above sea level, 1917.

The bed is situated in a glen sloping towards the bay, at the foot of rock ledges that rise gradually to about 20 m above it. The highest innermost part of the shell bed extends up to about 23 m. The deposit is rather large and 1.2 m thick. It is underlain by till. Samples were taken at bottom and top. The lower part of the bed contains a fair amount of mineral matter, the upper part relatively little — this latter largely consisting of *Mytilus* and *Balanus crenatus*.

The fauna contains 6 ax-forms, 15 a^{l}x-forms, 15 bx-forms, 5 b^{m}x-forms, and 9 b^{l}x-forms. Several species reach their northern limits on the Norwegian west coast and in the Oslofjorden and suggest a water temperature like that of today. Bathymetrically the fauna is comprised of 9 s-forms, 28 sd-forms, and 13 d-forms. *Mytilus*, *Littorina*, and *Lacuna* are well represented and increase in number upward. The d-forms are less numerously represented. The s-shells may be partly washed down, and the bed may have been deposited in a few meters of depth and at the shore during regression.

Havik.

Table p. 661.

12 km WNW of Fredrikstad, on the peninsula W of the Ellingårdskilen, 400 m S of Havik, just W of the road, altitude unknown, 1917.

The shell bed lies on level ground. It is large and more than 2.25 m thick. The bottom was not reached. The bed is covered by a layer of fine shell-free gravel 3 dm thick. Samples were taken at depths of 2.25, 1.5, and 0.75 m and at the top. The mineral content is throughout the bed fairly small. A small quantity of fragments of *Corallina officinalis* occurs in the bed as a whole.

The fauna is composed of 8 ax-forms, 15 a^{l}x-forms, 17 bx-forms, 6 b^{m}x-forms, and 11 b^{l}x-forms and, bathymetrically, of 8 s-forms, 29 sd-forms, and 18 d-forms. Shallow water and littoral species predominate throughout the bed and show but slight variations in frequency. The whole shell bed may have been formed in shallow water during the last regression, and the overlying shell-free gravel in the very shore line. As d-forms occur in fairly large numbers it is possible that they are partly derived from an older deposit formed in water of some depth.

Slependen.

Table p. 661.

14 km W of Oslo, on the west side of the road at Slependen, about 23 m above sea level, 1917.

The deposit is a clayey and stony oyster bed. Nearly one-half of the material consists of mineral matter. The bulk of the pebbles are thin, sharp-edged pieces of slate.

The fauna is composed of 5 ax-forms, 6 a^{l}x-forms, 9 bx-forms, 1 b^{m}x-form, and 6 b^{l}x-forms and, bathymetrically of 4 s-forms, 13 sd-forms, and 10 d-forms. All species are present only in few individuals. The deposit may have been formed in relatively deep water, perhaps about 20 m deep, and, judging from the numerous oyster shells, etc. during the last land upheaval.

Hermanö II.

Table p. 661.

12 km S of Lysekil, Hermanö, 1 km S of Gullholmen, 150 m S of the mouth of the deep bay from the east, about 3 m above sea level, 1917.

The shell bed occurs in a long cleft, 3 to 4 m wide. The bordering rock walls rise 4 to 5 m above the bed on the western side and 2 m on the eastern side. The deposit is of unknown extent and thickness. One sample was taken at the surface. The material contains but little mineral matter. It consists to a great part of fragments of oyster shells.

The fauna comprises 3 ax-forms, 12 a^{l}x-forms, 15 bx-forms, 4 b^{m}x-forms, and 7 b^{l}x-forms. It indicates somewhat higher water temperature than exists at present. In bathymetrical respect it is divided into 10 s-forms, 24 sd-forms, and 7 d-forms. *Littorina* and *Lacuna* are numerous. Together with many other species they may have lived on the rock ledges. The deposition may have taken place during the last rise, when the water surface stood about at the level of the rocks.

Hermanö I A.

Table p. 661.

See page 597. Here the top sample will be treated.

The composition of the fauna is 2 ax-forms, 9 a^{l}x-forms, 5 bx-forms and 2 b^{l}x-forms. *Bittium* and *Odostomia albella*, which have their northern limits at Trondhjem and Bergen, are present in solitary specimens.

The bathymetrical composition is 5 s-forms, 11 sd-forms, and 2 d-forms. The s-forms, notably *Mytilus*, predominate. The bed may have been formed at the shore.

Hermanö I B.

Table p. 661.

See page 597. Here the upper, late post-glacial bed lying above the disconformity will be treated. One sample from the middle of the deposit has been analyzed. The material contains some mineral gravel and fine sand.

The fauna has the composition 10 ax-forms, 14 a^{l}x-forms, 12 bx-forms, 6 b^{m}x-forms, and 6 b^{l}x-forms. The most southerly species now reach their limits of distribution at Bergen and in the Oslofjorden, indicating a temperature of the water like today's.

Bathymetrically the fauna consists of 13 s-forms, 24 sd-forms, and 11 d-forms. The species of the last group are present in few individuals. Part of the shells are probably redeposited; but not a great part, as can be judged from the very different appearance from the subjacent *Mytilus* bed. The bed was laid down either in the shore line or on very shallow water and probably during the last land upheaval.

Hermanö I C.

Table p. 661.

The same shell bed as Hermanö A and B. Some 50 m SE of A and 25 m from B. About 3 m above sea level. One sample near the top of the bed.

The material is very stony and sandy. The fauna is composed of 9 ax-forms, 16 a^{l}x-forms, 15 bx-forms, 5 b^{m}x-forms, and 8 b^{l}x-forms. No form, especially no southerly one, is plentiful. The most temperate species, *Tapes aureus*, *Scrobicularia*, and *Rissoa parva*, are dispersed northward to the Norwegian west coast. The top layers from which the sample was taken lie conformably on the typical *Mytilus* bed. They may consist of a mixture of redeposited *Mytilus* gravel and a younger late post-glacial gravel, and in its present state they date from the latter part of the last land upheaval.

Grundsund.

Table p. 662.

7.5 km S of Lysekil, 0.7 km SE of Grundsund Church, at the head of the bay, 1.5 m above sea level, 1917.

The deposit occurs at the narrowest part of a pass whose eastern side is formed by a rock wall that rises precipitously 5 m and whose western side consists of low rock ledges of gentle grade. It is of insignificant extent. It is 0.5 m thick and rests on bed rock. Samples were taken at bottom and top. The material contains a fair amount of mineral matter, the finest being sand. *Ostrea* shells are prominent.

The composition of the fauna is 6 ax-forms, 9 a^{l}x-forms, 12 bx-forms, 4 b^{m}x-forms, and 9 b^{l}x-forms and, bathymetrically, 7 s-forms, 23 sd-forms, and 10 d-forms. The water temperature may have been higher than at present. Both s-forms and d-forms are rather poorly represented. The shell gravel may have been deposited when the pass formed a sound some meters deep during the latter part of the last land rise.

Näset I.

Table p. 662.

See page 613. At this place the top bed, the Ostrea gravel will be treated. The material contains some mineral gravel, but no clay.

The fauna has the composition 2 ax-forms, 12 a^{l}x-forms, 10 bx-forms, 5 b^{m}x-forms, and 6 b^{l}x-forms, i. e. it is comparable to that in the lower bed and in modern shell deposits. With respect to the depths preferred by the molluscs the fauna contains 10 s-forms, 21 sd-forms, and 4 d-forms. Such species as *Mytilus*, *Littorina*, and *Lacuna* are well represented. The oysters may have lived on the adjacent rock walls. The superjacent cobbly gravel marks the last passing of the shore line. All considered, the bed may have been laid down in a few meters of water during the last upheaval.

Rörvik I.

Table p. 662.

4 km SSW of Hunnebostrand, at the crossroads N of R in Rörvik on the geological sheet, about 9 m above sea level, 1917.

The deposit occurs at the foot of a rock ledge about 2 m high. It is of unknown thickness. It consists of sandy gravel with shells.

The fauna contains 4 ax-forms, 12 a^{l}x-forms, 11 bxforms, 5 b^{m}x-forms, and 5 b^{l}x-forms. Bathymetrically it is divided into 7 s-forms, 24 sd-forms, and 6 d-forms, which last-mentioned are poorly represented. The deposit was formed at the shore and probably during the last uplift.

Rörvik II.

Table p. 662.

4.5 km SSW of Hunnebostrand, just W of V. Rörvik on the geological sheet, between 5 and 10 m above sea level, 1917.

The bed is situated in a glen about 35 m wide whose bordering rock walls rise steeply about 8 m. Extent and thickness are unknown. One sample has been studied. The material contains much mineral gravel and some clay. Large oyster shells are numerous.

The fauna is composed of 5 ax-forms, 12 a^lx-forms, 7 bx-forms, 3 b^mx-forms, and 6 b^lx-forms and, bathymetrically, of 8 s-forms, 19 sd-forms, and 6 d-forms. It indicates somewhat higher water temperature than at present. The bed may have heen deposited in a depth of a few meters when the glen formed a sound.

Vik IV.

Table p. 662.

1.5 km S of Bovallstrand, at the southeastern end of the Vikekilen, 10 m from the shore, 1 m above sea level, 1917.

The ground rises gently toward the east. The deposit is of unknown thickness. One sample was taken near the surface. The material is sandy mineral gravel with shells.

The fauna contains only 18 species divided into 2 ax-forms, 2 a^lx-forms, 9 bxforms, 1 b^mx-form, and 4 b^lx-forms and, bathymetrically, into 1 s-form, 10 sd-forms, and 7 d-forms. The bulk of the shells belongs to the sd-forms. While, therefore, the fauna is one from a depth of some 10 m, the consistency of the material shows that the bed was formed at the shore. Accordingly the shells probably are derived from an older deposit.

Florö.

Table p. 662.

3.5 km WSW of Fjällbacka, Florö, northern end, probably between 5 and 10 m above sea level, 1917.

The material is fine sandy gravel fairly rich in shells, a few of which are large. The fauna is composed of 5 ax-forms, 11 a^lx-forms, 8 bx-forms, 3 b^mx-forms, and 10 b^lx-forms and, bathymetrically, of 7 s-forms, 22 sd-forms, and 8 d-forms. Only very small species are present in fairly large numbers. The deposit may have been formed in shallow water or at the shore.

Hamn II.

Table p. 662.

5.5 km S of Fjällbacka, 200 m E of the Hombergssund, 300 m S of Rörvik, some 7 m above sea level, 1917.

The bed is situated on a gentle westward slope 20 m west of a rock ledge that gradually rises to about 20 m. It is of large extent but small thickness; at the examined exposure it was of a thickness of 1 m. It is underlain by cobbles and coarse gravel. Samples were taken at bottom and top. Nearly one-half of the material consists of mineral matter — gravel and sand. Fragments of oyster shells play a great rôle, especially in the lower part.

The fauna consists of 5 ax-forms, 11 a^{l}x-forms, 10 bx-forms, 3 b^{m}x-forms, and 7 b^{l}x-forms and, bathymetrically, of 9 s-forms, 21 sd-forms, and 6 d-forms. The last group is poorly represented as regards individuals. The bed evidently was formed in shallow water and at the shore and probably during the last rise of the land.

Tryggö.

Table p. 662.

4 km N of Gravarne, Tryggö, just S of the bifurcation of the sound, 20 m from the shore, behind the fisher-man's house, about 3 m above sea level, 1917.

The bed is situated in a wedge between rock ledges rising some 5 m above it. The thickness is unknown but is more than 1 m. Samples were taken at a depth of 1 m and at the surface. The material is rather stony and sandy and somewhat clayey. The upper part of the bed contains large oyster shells.

The fauna consists of 6 ax-forms, 12 a^{l}x-forms, 13 bx-forms, 7 b^{m}x-forms, and 10 b^{l}x-forms and, bathymetrically, of 9 s-forms, 26 sd-forms, and 13 d-forms. The numerous shells of *Ostrea* suggest somewhat higher temperature of the water than at present. The oysters may have lived attached to the rock walls. The deposition probably took place in a water depth of a few meters.

Hunnebo.

Table p. 662.

18.5 km NNW of Lysekil, 2 km S of Hunnebostrand, on the east side of the bay, 200 m from its head and 30 m from the shore, 1.5 m above sea level, 1917.

The bed is situated at the foot of a rock ledge rising 5 to 10 m above it. It extends for a distance along the ledge and is a few decimeters thick. It is an oyster bed. The material is very stony and somewat silty.

The fauna comprises 4 ax-forms, 8 a^lx-forms, 13 bx-forms, 3 b^mx-forms and 9 b^lx-forms. It suggests warmer water than today washes Bohuslän. Bathymetrically it consists of 7 s-forms, 20 sd-forms, and 10 d-forms. The oysters may have lived on the rock ledges. The bed may have been deposited at a few meters of water depth during the last uplift.

Ålstenshamn I.

Table p. 662.

4 km N of Gravarne, 300 m SE of the Ålstenshamn Sound where it forks, about 4 m above sea level, 1917.

The shell bed is situated in a cirque 50 m in diameter. The surrounding rock ledges rise gently 2 to 7 m above the deposit. It is 1.2 m thick, is underlain by bed rock, and overlain by 0.1 m of mold. Samples were taken at bottom, middle, and top. The mineral content is small in the lowest sample but increases upward; it is large in the top sample, in which worn pebbles are numerous. Fragments of *Corallina officinalis* are numerous in the middle sample and relatively sparse in two others.

The fauna comprises 4 ax-forms, 13 a^lx-forms, 16 bx-forms, 4 b^mx-forms, and 8 b^lx-forms and, bathymetrically, 11 s-forms, 25 sd-forms, and 9 d-forms. The upward decrease in numbers of such typical littoral and shallow forms as *Lacuna*, *Littorina*, and *Mytilus* may be chiefly due to the increasing percentage of the mineral gravel. The bulk of the bed may have been deposited in shallow water of diminishing depth, and the top layers in the shore line. The bed may date from the last uplift.

Ålstenshamn III.

Table p. 662.

4.5 km N of Gravarne, the head of the northward bay of the Ålstenshamn Sound, about 3 m above sea level, 1917.

The deposit occurs in a flat valley bordered by rock ledges that are a few meters high. An exposure showed:

Topmost, 3 dm shell-free sand.
3 dm fine gravel with shells
Pure sand.

Beside the species represented in the statistic sample the following were found: *Cardium edule*, *Lucina borealis*, *Mactra elliptica*, *Patella vulgata*, and *Tapes pullastra*.

The fauna has the composition 3 ax-forms, 11 a^lx-forms, 10 bx-forms, 3 b^mx-forms, 8 b^lx-forms, and 1 l-form — *Psammobia vespertina*, which suggests higher water temperature than today. As regards the bathymetrical distribution of the animals the fauna is divided into 12 s-forms, 19 sd-forms, and 5 d-forms. The shells are thus quite predominantly of shore and shallow-water molluscs. At the time of formation of the bed the valley formed a sound. The top may have been laid down in the very shore line as it receded; and the shelly sand may thus have been deposited below the water surface, though surely at insignificant depth. The deposit probably dates from the last uplift of the land.

Rödbrug I.

Table p. 663.

2 km WSW of Fredrikstad, 0.5 km S of the southward bay of the Græsviken, on the east side of the road 150 m N of the bend, probably between 10 and 15 m above sea level, 1917.

The deposit occurs at the foot of rock ledges which rise steeply some 15 m. It consists of shelly and stony clay. Prominent among the fossils is *Ostrea*.

The fauna comprises 4 ax-forms, 7 a^lx-forms, 8 bx-forms, 1 b^mx-form, and 7 b^lx-forms. In bathymetrical respect it is largely composed of molluscs that are equally frequent inside and outside the depth curve of 10 m, the composition being 4 s-forms, 18 sd-forms, and 5 d-forms. No species is numerous. The deposit may have been formed on a water depth of several meters during the last uplift of the land.

Rödbrug II.

Table p. 663.

2 km WSW of Fredrikstad, 300 m W of Rödbrug I and 400 m E of the bay, about 14 m above sea level, 1917.

The bed is to be found in an east-west glen about 50 m wide. It rests against the foot of the southern rock wall, which rises step-like so as to reach about 7 m above the valley bottom at a distance of 25 m. The bed is 0.5 m thick. Somewhat more than one-half of the material is mineral matter, an insignificant part of which is clay.

The fauna contains 6 ax-forms, 12 a^lx-forms, 12 bx-forms, 5 b^mx-forms, anp 7 b^lx-forms and is comparable to that of modern beds.

Bathymetrically it is composed of 8 s-forms, 21 sd-forms, and 13 d-forms. No species is abundant. *Littorina* is barely represented. The hed may have been laid down in shallow water and during the last rise.

Groten II.

Table p. 663.

10.5 km SE of Fredrikstad, the east side of the Tosekilen, in lat. 59° 10′, about 200 m N of Groten I, 15 m from the bay, about 8 m above the sea, 1917.

The bed occurs near the foot of a steep rock ledge 30 m high. It is 1 m thick and is underlain by sand. Samples were taken at bottom and top. The mineral content is small at bottom but fairly large at top. It consists partly of clay. Fragments of *Mytilus edulis* play a great rôle, especially near the bottom.

The fauna contains 6 ax-forms, 13 a^lx-forms, 16 bx-forms, 5 b^mx-forms, aud 8 b^lx-forms and, bathymetrically, 5 s-forms, 23 sd-forms, and 20 d-forms. The water temperature may have been as now or slightly higher. The d-forms, though numerous in species, are few in individuals. However, the s-forms may have largely lived on the rock ledge, and the bed may have been deposited in a water depth of several meters during the last land upheaval.

Ödegården.

Table p. 663.

5.5 km S of Fredrikstad, 0.6 km W of the bay, S of the road leading to Ödegården, between 10 and 15 m above sea level, 1917.

The deposit occurs on a gentle northward slope of a rocky ridge, which some 25 m in the south rises about 5 m higher. It is of small extent and only 0.85 m thick. It rests on pure sand. Samples were taken at bottom and top. The lower sample consists of equal quantities of shells and mineral matter, the upper sample of a greater quantity of shells than mineral matter. The finest mineral material is sand.

The fauna is composed of 4 ax-forms, 11 a^lx-forms, 14 bx-forms, 3 b^mx-forms, and 8 b^lx-forms. It suggests a water temperature like the present. In bathymetrical respect it consists of 11 s-forms, 21 sd-forms, and 8 d-forms. Molluscs common on the shore and in shallow water predominate. The bed resembles modern upwashed shell accumulations. It may date from the last passing of the shore line.

Lavösund I.

Table p. 663.

12.5 km S of Lysekil, Lavö, 10 m from the shore and just S of the highway bridge, 1.8 m above sea level, 1917.

The bed is situated at the foot of a rock ledge that rises 8 m above it. It is small and 1 m thick. It rests on pure gravel and is overlain by 1.5 dm of shell-free gravel. One sample has been analyzed. The material is fairly stony and sandy. It consists predominantly of shell fragments of *Ostrea.*

The fauna is composed of 1 ax-form, 4 a^{l}x-forms, 5 bx-forms, 4 b^{m}x-forms, and 7 b^{l}x-forms. The numerous oyster shells may indicate higher water temperature than exists today. With respect to the bathymetrical occurrence of the molluscs the composition is 4 s-forms, 13 sd-forms, and 4 d-forms. Except for *Ostrea* no species is numerously represented. The oysters may have lived on the adjacent rocks, and the bed may have been formed in shallow water during the last rise. The capping gravel was deposited, as the shore line passed.

Hovenäs III.

Table p. 663.

See page 614. Here the shell gravel resting on the clay bed will be treated.

The material is sandy and clayey mineral gravel rich in shells. The fauna consists of 12 species divided into 2 ax-forms, 3 a^{l}x-forms, 3 bx-forms, and 4 b^{l}x-forms. With the exception of *Montacuta bidentata* all the species are common in very shallow water or at the shore. The shell gravel may have been laid down a little outside the shore, and the covering coarse gravel in the very shore line. The bed probably dates from the last rise of the land.

·Svenneby II.

Table p. 663.

2 km NW of Bovallstrand, on Valön, opposite the western end of Långö, near the shore, 3 m above sea level, 1917.

The bed is situated at the eastern foot of a rock ledge which rises steeply 5 m above it. It was small, and in 1917 was practically removed. The material contains some fine mineral gravel and a fair amount of sand but no clay.

The fauna contains 4 ax-forms, 13 a^{l}x-forms, 10 bx-forms, 3 b^{m}x-forms, and 5 b^{l}x-forms and suggests about as high water temperature as in our time. Bathymetrically it is divided into 10 s forms, 20 sd-forms, and 5 d-forms. Shells of molluscs common on the shore and in very shallow water predominate, whereas d-forms are poorly represented. Thus the deposit resembles modern littoral beds. Two transparent not yet calcined shells of *Rissoa membranacea* that were observed suggest relatively low age. The deposit may accordingly date from the last uplift.

Vik II.

Table p. 663.

1.5 km S of Bovallstrand, the southeastern head of the Vikekilen, 10 m from the shore, 1 m above sea level, 1917.

The bed lies at the northern foot of a rock ledge which gradually rises 5 m and at greater distance somewhat higher. It has been largely removed It is 0.5 m thick. Samples were taken at bottom and top. The material contains nearly as much mineral matter as shells.

The fauna is composed of 7 ax-forms, 12 a^{l}x-forms, 12 bx-forms, and 4 b^{m}x-forms, and 9 b^{l}x-forms. Bathymetrically it is divided into 6 s-forms, 22 sd-forms, and 16 d-forms. The s-forms as well as the d-forms are represented by few individuals. Whereas the fauna suggests deposition in a depth of several meters, the material is littoral in character. It is therefore probable that the bed was formed at the shore or in very shallow water during the last upheaval and that part of the shells are derived from an older deposit formed at some depth.

Vikekilen I.

Table p. 663.

1 km S of Bovallstrand, at the head of the NE branch of the Vikekilen, 25 m from the shore, 1.3 m above sea level, 1917.

The bed is situated on the flat bottom of a valley. In the west, at a distance of 20 m, rock ledges rise 4 to 6 m above the bed; and in the east, at a distance of 60 m, they rise to about 10 m. The deposit probably has a considerable extent and is more than 0.75 m thick. Samples were taken at a depth of 0.75 m and at the top. The material consists largely of pebbles and sand.

The fauna is composed of 8 ax-forms, 11 a^{l}x-forms, 13 bx-forms, 3 b^{m}x-forms, and 8 b^{l}x-forms and, bathymetrically, of 5 s-forms, 26 sd-forms, and 13 d-forms. The bed may have been deposited fairly recently in the very shore line, for a similar bed — probably the continuation of the bed here treated — is now forming between the tidal limits at the adjacent shore.

Svenneby IV.

Table p. 663.

2.5 km NNW of Bovallstrand, Valön, N of bay on the south-eastern side, 50 m from the shore in the center of the valley, 1.5 m above sea level, 1917,

The deposit is sandy shell gravel some 2 dm thick, resting on pure sand. The fauna contains 4 ax-forms, 16 a^lx-forms, 6 bx-forms, 2 b^mx-forms, and 4 b^lx-forms. The warmest species is *Rissoa parva* now distributed as far as the Nordfjorden. With respect to the water depth preferred by the molluscs the fauna is divided into 10 s-forms, 16 sd-forms, and 6 d-forms. The last group plays a subordinate rôle. The deposit resembles the shell gravel now accumulating by upwashing at the adjacent shore and was undoubtedly formed in the same manner during the latter part of post-glacial time or in recent time.

Ålstenshamn II.

Table p. 663.

4 km N of Gravarne, in the Ålstenshamn Sound just S of its branching, 0.4 m above sea level, 1917.

In recent, or more probably modern, time a land connection which is only transgressed by the sea at exceptionally high water, has been formed at the narrowest and most protected part of the Ålstenhamn Sound. In this neck of land the following profile was observed:

Topmost, 2 dm shell gravel. Sample (p. 505).
0.6 dm peat.
>4 dm shell gravel. Sample at a depth of 3 dm.

Here the lower bed will be treated. The material is fairly stony and sandy. The fauna consists of 5 ax-forms, 11 a^lx-forms, 12 bx-forms, 7 b^mx-forms, and 10 b^lx-forms and is thus fully as warm as the warmest modern bed examined. With respect to the bathymetrical distribution the fauna contains 9 s-forms, 25 sd-forms, and 11 d-forms. The last-mentioned play a subordinate rôle, whereas species frequent in shallow water and at the shore are numerously represented. The fauna is thus comparable to that in modern upwashed shell accumulations; and the bed may have been accumulated in recent or modern time under conditions similar to those under which the Smalsundet bed is now forming.

IX. Tables.

The earlier group of tables contains the late-glacial shell beds, the later group the post-glacial beds. The beds are arranged according to age, so that the time of immigration of the animals and their variations in frequency with time can be conveniently made out. The animals are arranged in alphabetic order. The names that are best known in geological literature have been used. A list of synonyms is given on page 726.

The figures indicate number of individuals per one-tenth liter of shell gravel. (The tables in the paper of 1917 give individuals per liter of material. In them, furthermore, the fractions 1—2 mm and 2 < mm are kept apart.)

»Vik A» and »Vik B» signify different series of samples of the same bed. »Vik I» and »Vik II» denote separate deposits. The figures below the locality names give the pages of description. An »a.» in front of an altitude figure signifies »about». Practically all the altitudes were determined by aneroid. The symbols expressing the geographical and the bathymetrical range are as follows (cf. pp. 489–495):

a	arctic region
ah	high-arctic subregion
al	low-arctic »
b	boreal region
bh	high-boreal subregion
bm	mid-boreal »
bl	low-boreal »
l	lusitanian region
w = abl	
s	shallow-forms: living preferably inside depth curve of 10 m
d	deep-forms: » » outside » » »
sd	shallow-deep-forms: equally common inside and outside depth curve of 10 m.

The even pages should be read by the aid of the flap to the left — on the first page of the section. The odd pages should be read by the aid of the flap to the right — on the last page of the section. The figures in the margin denote the number of order of the animals. The figures at bottom and top indicate the pages on which and from which the tables are continued.

1				Gothi-glacial uplift							Fini-glacial uplift							
				Noleröd	Önna		Tossene		Tumlehed		Moen				Kilebråten			Kra pet lier
				p. 580	p. 581		p. 581		p. 582		p. 583				p. 583			p. 58
Number of samples					1	2	1	2	1	2	1	2	3	4	1	2	3	1
Locality: height in m above sea level				aa. 30	a. 59		a. 46		aa 20		a. 139				a. 150			a. 13
Samples: »					a. 58.3	a. 59	a. 45	a. 46	18.7	20	136.7	137.5	138.2	139	149	149.5	150	135
Weight in gr of whole sample. 0.2 dm^3				294	224	263	210	238	286	287	230	253	255	256	200	190	189	283
» material 2 < mm				120	153	197	56	42	115	75	55	62	50	47	84	116	90	18
» » 1—2 mm				44	18	28	5	10	62	61	48	66	53	46	63	62	34	32
Analyzed part of dm^3 of material 2 < mm				1/10	1/10	1/10	1/5	1/5	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/5
» 1—2 mm				1/30	1/10	1/20	1/5	1/10	1/40	1/30	1/30	1/40	1/30	1/30	1/40	1/40	1/20	1/20
bml	d	1 *Abra alba*																
bml	d	2 *Actaeon tornatilis*																
a^{l}bl	sd	3 *Anomia aculeata*																
a^{l}bl	sd	4 » *ephippium*	4	1	—	—	—	—	—	—	—	—	—	—	—	—	1/2	—
ab^{h}	d	5 *Astarte borealis*																
ab	d	6 » *elliptica*																
ab	d	7 » *montagui*	7	1/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
w	sd	8 *Balanus crenatus*	8	240	—	4	—	23	60	95	1 300	875	1 130	875	395	480	370	290
ab	d	9 » *porcatus*	9	1	32	22	10	2	—	3	1	—	1	1	1	6	2	—
ab	sd	10 *Boreochiton marmoreus*	10	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—
ab	d	11 » *ruber*																
a	sd	12 *Buccinum groenlandicum*																
ab	d	13 » *undatum*	13	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
bl	s	14 *Cardium edule*																
bl	sd	15 » *exiguum*																
bl	sd	16 *Corbula gibba*																
bl	s	17 *Craspedochilus marginatus*																
a^{l}bl	sd	18 *Cyamium minutum*																
a^{l}b	d	19 *Cyprina islandica*																
bl	sd	20 *Gibbula cineraria*																
a^{l}bl	d	21 » *tumida*																
a^{l}bl	s	22 *Hydrobia ulvae*																
a^{l}bl	s	23 *Lacuna divaricata*																
ab	d	24 *Leda minuta*																
ab	d	25 *Lepeta caeca*																
bl	d	26 *Lepidopleurus asellus*																
a^{l}bl	s	27 *Littorina littorea-rudis*	27	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
a^{l}bl	s	28 » *obtusata*																

Continued on page 650

Fini-glacial uplift

1

d	Kilen		Hagtorn	Lindal			Sparöd		Slätthult			Yllene				
35	p. 585		p. 586	p. 587			p. 588		p. 588			p. 589				
	1	2		1	2	3	1	2	1	2	3	1	2	3	4	. . .
22	a. 124		a. 110	a. 93			a. 66		a. 47			aa. 50				. . .
	123.2	124		91	92	93	65.2	65.7	46	46.5	47	46.7	47.6	48.5	49.5	. . .
	180	198	248	313	226	180	214	252	220	226	245	253	233	330	310	. . .
	130	104	113	148	90	68	65	123	45	70	83	60	76	160	172	. . .
	30	52	58	75	55	54	34	52	93	93	100	20	50	68	66	. . .
	1/10	1/20	1/10	1/10	1/10	1/10	1/20	1/20	1/20	1/20	1/20	1/5	1/10	1/10	1/10	. . .
	1/20	1/30	1/30	1/30	1/30	1/30	1/30	1/30	1/50	1/50	1/50	1/10	1/30	1/30	1/40	. . .
—	—	—	—	1/2	2	—	—	—	—	—	—	—	2	—	—	4 . .
—	—	—	—	—	—	—	—	—	—	—	—	1/2	—	—	—	6 . .
5	110	775	140	310	460	1 055	325	485	700	465	435	42	600	210	225	8 . .
1	3	6	1	2	2	1	5	4	+	2	2	4	1	6	2	9 . .
—	—	—	—	+	—	—	—	—	—	—	—	—	+	—	—	11 . .
—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12 . .
—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	13 . .
—	—	—	—	—	—	—	—	—	—	8	—	—	—	—	—	18 . .
—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	21 . .
—	—	—	—	1	—	—	—	—	15	7	—	—	13	—	—	23 . .
—	—	—	—	1	—	—	—	—	—	—	—	1	1	1	—	25 . .
—	—	—	—	1	2	1	—	3	19	2	2	—	—	9	7	27 . .

1

Fini-glacial uplift

	Skistad			Nordby		Häste-källa		Lur		Lyrön			Stensb		
	p. 590			p. 590		p. 591		p. 592		p. 592			p. 593		
. . . .	1	2	3	1	2	1	2	1	2	1	2	3	1	2	3
. . . .	a. 51			a. 43		a. 35		a. 59		a. 29			a. 26		
. . . .	49	50	51	42	43	31.5	32.5	58.5	59	27.3	28.2	29	23	24	25
. . . .	337 22 56	296 58 54	310 56 75	231 46 36	220 68 38	246 70 34	300 30 28	346 86 82	317 47 40	266 160 38	276 112 66	245 88 30	272 177 66	306 254 45	277 200 36
. . . .	1/5 1/30	1/10 1/30	1/10 1/40	1/5 1/30	1/5 1/30	1/10 1/30	1/10 1/20	1/5 1/25	1/10 1/20	1/10 1/40	1/10 1/40	1/10 1/20	1/10 1/30	1/10 1/20	1/10 1/20
. . 1	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—
. . 3	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—
. . 4	—	—	—	—	—	—	—	—	—	16	—	—	—	—	—
. . 5	—	—	—	—	—	—	—	—	—	—	—	1/2	—	—	—
. . 6	—	—	—	+	—	—	—	+	—	+	—	—	—	—	—
. . 7	—	—	—	—	—	—	—	—	—	1	—	—	—	—	+
. . 8	150	505	365	220	80	100	290	218	185	107	340	640	150	125	145
. . 9	—	—	6	+	—	1	2	—	2	64	7	6	3	10	7
. . 10	—	—	—	—	—	—	—	+	—	—	+	—	—	—	—
. . 11	—	—	—	—	+	—	—	—	—	—	—	+	—	—	—
. . 13	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—
. . 14	—	—	—	—	—	—	—	—	—	—	1/2	4	—	—	—
. . 20	—	—	—	—	—	—	—	+	+	3	—	—	—	—	—
. . 21	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. . 22	—	—	—	—	—	—	—	5	—	—	—	—	—	—	—
. . 23	—	18	1	6	—	—	—	3	6	2	12	—	9	—	—
. . 25	—	—	2	—	—	—	—	—	2	3	—	—	—	—	—
. . 27	4	26	21	14	27	3	8	18	11	—	4	6	2	2	+
. . 28	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
. . .	652														

Fini-glacial uplift

1

Sanderöd				Glimsås	Huseby		Morlanda	Hermanö I A			Hermanö I B	Tången II					
p. 594				p. 595	p. 595		p. 596	p. 596				p. 598					
1	2	3	4		1	2		1	2	3	1	1	2		Number of samples		
a. 23				aa. 20	10 to 20		a. 5	3.5			2.2	a. 2			Locality: height in m above sea level		
21.2	21.8	22.4	23		×—1	×	5	1	1.9	2.7	2.1	0.3	1.2		Samples: ›		
287	238	164	196	345	353	327	340	265	282	272	167	240	238		Weight in gr of whole samples, 0.2 dm^3		
48	46	83	114	150	86	178	140	18	34	33	98	48	38		› material 2 < mm		
30	50	36	20	58	62	68	87	60	84	100	40	20	60		› › 1—2 mm		
1/5	1/10	1/10	1/10	1/5	1/5	1/10	1/5	1/10	1/10	1/10	1/20	1/20	1/10		Analyzed part of dm^3 of material 2 < mm		
1/20	1/40	1/30	1/20	1/20	1/40	1/40	1/30	1/50	1/50	1/50	1/30	1/20	1/50		› › 1—2 mm		
—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	1 *Abra alba*	bml	d
—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	2 *Actaeon tornatilis*	bml	d
—	—	3	—	—	—	—	—	—	—	—	—	—	1	3	3 *Anomia aculeata*	$\mathrm{a^1bl}$	sd
															4 › *ephippium*	$\mathrm{a^1bl}$	sd
—	—	—	—	—	—	1/2	+	—	—	—	—	—	—	5	5 *Astarte borealis*	abh	d
—	—	—	—	1	+	—	—	—	—	1	—	—	—	6	6 › *elliptica*	ab	d
—	—	—	—	—	1	3	—	—	—	1	—	—	—	7	7 › *montagui*	ab	d
11	180	600	670	42	130	160	70	250	200	260	565	300	185	8	8 *Balanus crenatus*	w	sd
1	5	11	7	2	12	24	5	—	—	—	—	4	—	9	9 › *porcatus*	ab	d
															10 *Boreochiton marmoreus*	ab	sd
—	+	—	—	—	—	+	—	—	—	—	—	+	1	11	11 › *ruber*	ab	d
															12 *Buccinum groenlandicum*	a	sd
—	1	—	1	—	—	—	—	—	—	—	—	—	—	13	13 › *undatum*	ab	d
—	—	—	5	—	—	—	—	—	—	—	—	—	—	14	14 *Cardium edule*	bl	s
—	—	—	—	+	—	—	—	—	—	—	—	1	—	15	15 › *exiguum*	bl	sd
—	—	—	—	—	—	—	1	—	—	—	—	—	—	16	16 *Corbula gibba*	bl	sd
—	—	+	—	—	—	—	—	—	—	—	—	—	—	17	17 *Craspedochilus marginatus*	bl	s
—	—	—	—	—	—	—	—	—	—	3	—	—	—	18	18 *Cyamium minutum*	$\mathrm{a^1bl}$	sd
—	—	—	—	—	—	—	—	—	—	—	—	—	1	19	19 *Cyprina islandica*	$\mathrm{a^1b}$	d
4	13	4	5	—	—	—	2	—	—	5	—	—	—	20	20 *Gibbula cineraria*	bl	sd
—	—	—	—	—	—	—	—	—	—	—	—	4	1	21	21 › *tumida*	$\mathrm{a^1bl}$	d
—	—	—	—	2	—	—	—	—	—	—	—	—	—	22	22 *Hydrobia ulvae*	$\mathrm{a^1bl}$	s
13	60	70	8	—	—	1	—	15	25	2	96	26	82	23	23 *Lacuna divaricata*	$\mathrm{a^1bl}$	s
—	—	—	—	—	—	—	—	—	—	—	+	—	—	24	24 *Leda minuta*	ab	d
2	1	1	—	—	—	—	+	—	—	—	—	—	—	25	25 *Lepeta caeca*	ab	d
—	—	—	—	—	—	—	—	—	—	—	—	+	—	26	26 *Lepidopleurus asellus*	bl	d
—	2	29	53	9	7	30	2	25	1	5	20	2	15	27	27 *Littorina littorea-rudis*	$\mathrm{a^1bl}$	s
—	—	—	4	—	—	—	—	—	—	—	—	—	—	28	28 › *obtusata*	$\mathrm{a^1bl}$	s

653 . . . . Continued on page.

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Continued from page 646

				Gothi-glacial uplift							Fini-glacial uplift									
				Noleröd	Önna		Tossene		Tumlehed		Moen				Kilebråten			Krappetolien	
				p. 580	p. 581		p. 581		p. 582		p. 583				p. 583			p. 584	
		Number of samples			1	2	1	2	1	2	1	2	3	4	1	2	3	1	2
		Height »		30	58.3	59	45	46	18.7	20	136.7	137.5	138.2	139	149	149.5	150	135	13
ab	d	1 *Lunatia groenlandica*																	
albl	s	2 *Macoma baltica*	2	3	—	—	—	—	—	1	1	5	—	2	—	½	—	—	—
abm	d	3 » *calcaria*	3	½	—	—	+	—	—	—	—	—	—	—	—	½	—	+	+
bl	s	4 » *tenuis*																	
ab	d	5 *Margarita cinerea*																	
ab	d	6 » *groenlandica*																	
ab	d	7 » *helicina*	7	—	—	—	—	—	—	4	—	—	—	—	—	1	—	—	—
a	sd	8 *Modiolaria corrugata*	8	—	—	—	—	—	½	7	—	—	—	—	—	—	—	—	—
a	sd	9 » *discors v. laevigata*																	
ab	d	10 *Moelleria costulata*	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
bl	d	11 *Montacuta bidentata*																	
w	sd	12 *Mya truncata*	12	1	—	½	—	½	½	2	2	—	1	½	—	½	—	—	8
albl	s	13 *Mytilus edulis*	13	3	+	1	—	3	2	+	9	10	7	6	19	15	35	½	4
alb	sd	14 » *modiolus*																	
w	d	15 *Natica affinis*																	
albl	s	16 *Onoba aculeus-striata*	16	—	—	—	—	—	—	—	—	—	—	—	—	—	2	4	3
bl	d	17 *Parthenia spiralis*																	
b	s	18 *Patella vulgata*																	
abh	d	19 *Pecten islandicus*	19	+	+	—	—	—	+	—	—	—	—	—	—	—	—	—	—
w	d	20 *Portlandia lenticula*	20	—	—	—	—	½	—	—	—	—	—	—	—	—	—	—	—
ab	d	21 *Puncturella noachina*	21	3	—	—	½	—	—	—	—	—	—	—	—	—	—	2	—
alb	s	22 *Purpura lapillus*																	
a	d	23 *Rhynchonella psittacea*																	
albl	sd	24 *Rissoa interrupta*																	
w(a)	sd	25 *Saxicava arctica*	25	20	3	2	7	25	30	17	36	16	38	18	16	13	24	32	35
bl	sd	26 *Solen ensis*																	
a	sd	27 *Tectura rubella*	27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
albl	sd	28 » *virginea*																	
bmbl	sd	29 *Thracia villosiuscula*																	
abm	d	30 *Trophon clathratus*	30	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
bl	sd	31 *Venus ovata*																	
albl	sd	32 *Verruca stroemia*	32	—	—	—	—	—	+	—	+	+	3	—	2	4	+	2	5
alb	s	33 *Zirphaea crispata*	33	—	—	—	—	—	—	—	—	½	—	—	—	—	—	—	—

Fini-glacial uplift

647

2

Ås- ård	Kilen		Hag- torn	Lindal			Sparöd		Slätthult			Yllene				
585	p. 585		p. 586	p. 587			p. 588		p. 588			p. 589				
	1	2		1	2	3	1	2	1	2	3	1	2	3	4	. .
22	123.2	124	110	91	92	93	65.2	65.7	46	46.5	47	46.7	47.6	48.5	49.5	. .
—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	1 .
1/2	—	1	2	1/2	1/2	1/2	—	—	—	—	—	1	3	1/2	2	2 .
—	—	—	—	—	—	1/2	—	1	1	—	—	—	—	1/2	—	3 .
—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	5 .
—	—	—	—	—	—	—	—	—	27	5	—	—	3	—	—	7 .
—	1	—	—	—	1/2	—	—	—	—	—	—	—	—	—	—	8 .
—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	9 .
—	—	—	3	—	—	—	3	—	—	7	—	1	—	—	—	10 .
2	1/2	—	—	1/2	1/2	3	3	1	1	—	—	—	4	—	—	12 .
10	53	42	93	35	105	9	9+	23	11	12	5	5	9	3	—	13 .
—	1/2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14 .
—	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	15 .
—	—	—	18	3	3	3	—	6	15	20	—	—	27	—	—	16 .
—	+	+	—	—	—	—	—	1	—	—	+	—	+	+	+	19 . .
—	—	—	—	—	4	1	3	2	—	—	—	—	—	—	1	21 . .
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	23 . .
—	—	—	—	—	—	—	—	—	10	—	—	—	—	—	—	24 . .
93	32	115	24	23	20	30	30	80	112	45	22	4	115	25	15	25 . .
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	27 . .
—	—	—	3	1	3	1	—	2	—	—	—	—	2	—	1	28 . .
—	—	—	—	—	—	—	2	—	—	—	—	1	—	—	—	30 . .
1	1	4	3	1	5	1	—	3	15	14	14	—	4	1	2	32 . .

2

Fini-glacial uplift

648

	Skistad			Nordby		Häste-källa		Lur		Lyrön			Stensbo		
	p. 590			p. 590		p. 591		p. 592		p. 592			p. 593		
. .	1	2	3	1	2	1	2	1	2	1	2	3	1	2	3
. .	49	50	51	42	43	31.5	32	58.5	59	27.3	28.2	29	23	24	25
. 2	—	—	3	1	1	—	1/2	—	—	—	—	—	—	—	—
. 3	—	—	—	+	—	—	—	+	—	1	+	—	—	—	—
. 6	—	—	—	—	—	—	—		—	—	—	—		—	1
. 12	—	1/2	—	+	+	—	—	—	+	2	—	—	—	1	—
. 13	19	13	13	77	10 +	17 +	23 +	64	47	1	27	17	15	8	20
. 15	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
. 16	—	6	4	—	—	—	—	8	6	28	8	—	3	—	2
. 19	—	+	+	+	+	—	—	—	—	+	+	—	—	+	+
. 21	—	—	—	—	—	—	—	—	—	5	—	—	—	—	—
. 22	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—
. 24	—	3	—	—	—	3	—	—	—	—	—	4	—	—	—
. 25	+	—	6	1/2	—	—	—	15	4	30	9	9	11	15	10
. 28	4	—	2	—	—	—	—	3	2	5	1	10	—	1	—
. 30	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
. 32	4	7	5	+	—	—	—	16	2	9	11	7	1	3	3

Fini-glacial uplift

549

2

. . . . Continued from page

Sanderöd				Glimsås	Huseby		Morlanda	Hermanö I A			B	Tången II					
p. 594				p. 595	p. 595		p. 596	p. 596				p. 598					
1	2	3	4		1	2		1	2	3	1	1	2		. . . . Number of samples		
21.2	21.8	22.4	23	20	×—1	×	5	1	1.9	2.7	2.1	0.3	1.2		. . . . Height		
															. . . . 1 *Lunatia groenlandica*	ab	d
—	—	½	2	1	2	4	—	—	—	—	—	—	—	2	. . . . 2 *Macoma baltica*	a^{l}bl	s
—		—	-	2	—	—	—	—	—	—	—	—	—	3	. . . . 3 » *calcarica*	ab^{m}	d
—	—	—	—	—	—	—	—	—	—	—	2	—	—	4	. . . . 4 » *tenuis*	bl	s
															. . . . 5 *Margarita cinera*	ab	d
															. . . . 6 » *groenlandica*	ab	d
—	16	3	2	—	—	—	—	—	—	—	6	—	—	7	. . . . 7 » *helicina*	ab	d
															. . . . 8 *Modiolaria corrugata*	a	sd
															. . . . 9 » *discors* v. *laevigata* .	a	sd
															. . . . 10 *Moelleria costulata*	ab	d
—	—	3	2	1	—	2	—	—	5	—	—	1	5	11	. . . . 11 *Montacuta bidentata*	bl	d
—	½	—	+	2	1	½	—	—	—	3	6	—	1	12	. . . . 12 *Mya truncata*	w	sd
5+	525	570	75	+	+	2	17	295	600	400	245	240	300	13	. . . . 13 *Mytilus edulis*	a^{l}bl	s
															. . . . 14 » *modiolus*	a^{l}b	sd
—	—	—	—	—	—	—	—	—	—	—	5	—	—	15	. . . . 15 *Natica affinis*	w	d
8	24	12	12	—	—	4	—	10	—	—	15	6	10	16	. . . . 16 *Onoba aculeus-striata*	a^{l}bl	s
—	—	—	—	—	—	—	—	—	—	—	—	—	5	17	. . . . 17 *Parthenia spiralis*	bl	d
—	—	—	—	—	—	—	—	—	—	—	—	—	1	18	. . . . 18 *Patella vulgata*	b	s
½	—	+	+	—	—	+	+	—	—	1	+	—	—	19	. . . . 19 *Pecten islandicus*	ab^{h}	d
															. . . . 20 *Portlandia lenticula*	w	d
—	—	—	2	—	—	—	—	—	—	—	—	—	—	21	. . . . 21 *Puncturella noachina*	ab	d
															. . . . 22 *Purpura lapillus*	a^{l}b	s
															. . . . 23 *Rhynchonella psittacea*	a	d
—	20	15	6	—	—	—	—	20	10	—	18	8	35	24	. . . . 24 *Rissoa interrupta*	a^{l}bl	sd
5	32	17	8	3	12	16	6	11	—	—	9	14	10	25	. . . . 25 *Saxicava arctica*	w(a)	sd
—	—	—	—	—	—	—	+	—	—	—	—	—	+	26	. . . . 26 *Solen ensis*	bl	sd
															. . . . 27 *Tectura rubella*	a	sd
1	29	—	5	—	—	—	—	11	5	—	23	4	1	28	. . . . 28 » *virginea*	a^{l}bl	sd
—	—	—	—	—	—	—	—	—	—	3	—	—	—	29	. . . . 29 *Thracia villosiuscula*	b^{m}bl	sd
															. . . . 30 *Throphon clathratus*	ab^{m}	d
—	—	—	—	—	—	—	1	—	—	—	—	—	—	31	. . . . 31 *Venus ovata*	bl	sd
+	—	11	8	1	1	6	5	—	5	20	3	—	—	32	. . . . 32 *Verruca stroemia*	a^{l}bl	sd
															. . . . 33 *Zirphaea crispata*	a^{l}b	s

1					Ancylus sinking						Ancylus uplift								
					Gudebo	Skårbo			Knutsdalen		Bredhult		Skärjedalen	Oxtorp	Ullerö	Tose			Häste källa
					p. 598	p. 599			p. 600		p. 600		p. 601	p. 602	p. 603	p. 604			p. 604
Number of samples						1	2	3	1	2	1	2				1	2	3	
Locality: Height in m above sea level					a. 48	a. 46			a. 54		a. 71		63	a. 50	a. 59	a. 57			a. 35
Samples: »					46.3	44.2	45.2	46	53	54	70	71		49		55.8	56.4	57	33.5
Weight in gr of whole sample, 0.2 dm^3					353	315	225	225	310	310	258	210	285	340	246	225	240	260	340
» material 2 < mm					70	47	100	90	30	75	15	40	80	70	62	43	105	140	150
» » 1—2 mm					45	48	50	65	52	110	50	70	84	47	27	44	48	55	46
Analyzed part of dm^3 of material 2 < mm					1/5	1/10	1/15	1/15	1/5	1/5	1/5	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/5
» 1—2 mm					1/15	1/20	1/25	1/25	1/30	1/50	1/40	1/50	1/30	1/30	1/20	1/40	1/50	1/50	1/3
bml	d	1	*Abra alba*	1	+	1	—	—	—	—	—	—	—	—	—	—	—	—	—
bml	d	2	» *longicallis*																
bl	d	3	» *nitida*																
		4	» sp.	4	—	—	—	—	—	—	2	—	—	—	+	2	3	—	1
b^{l}l	s	5	*Alvania lactea*																
bl	d	6	» *punctura*	6	—	—	—	—	—	—	—	5	—	—	2	8	5	—	—
b^{l}l	d	7	» *reticulata*																
bml	d	8	» *zetlandica*																
a^{l}bl	sd	9	*Anomia aculeata*	9	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
a^{l}bl	sd	10	» *ephippium*	10	2	2	—	—	—	—	+	—	4	—	+	—	—	—	—
bml	d	11	» *patelliformis-striata*																
bl	d	12	*Aporrhais pes pelicani*	12	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—
bml	d	13	*Arcinella plicata*																
ab^{h}	d	14	*Astarte borealis*																
ab	d	15	» *elliptica*																
ab	d	16	» *montagui*	16	—	—	—	—1	1/2	—	—	—	—	1/2	—	—	—	—	—
a^{l}bl	d	17	» *sulcata*																
b^{l}l	d	18	*Atys utriculus*																
w	d	19	*Axinus flexuosus*																
b	d	20	» *sarsi*																
		21	» sp.																
w	sd	22	*Balanus crenatus*	22	27	29	290	450	135	390	165	230	400	300	2	—	—	46	170
a^{l}b	d	23	» *hameri*																
ab	d	24	» *porcatus*	24	3	+	—	—	—	2	—	6	1	1	—	—	—	—	6
b^{l}l	sd	25	*Bittium reticulatum*	25	—	—	—	—	—	—	—	—	—	—	40	—	—	15	—

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Ancylus uplift

Udden I					Lavö			Fyka					Lersten					
p. 605					p. 605			p. 606					p. 607					
1	2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	4	5	. . .
a. 36					a. 20			a. 23					a. 19					. . .
33	34	35	35.5	36	18	19	20	20.2	21	21.7	22.5	23	15	16	17	18	19	. . .
32	173	230	225	220	280	210	255	250	225	305	260	320	240	170	170	230	270	. . .
54	73	107	85	90	45	40	96	18	67	55	130	120	20	75	75	58	60	. . .
42	38	50	44	50	58	32	100	40	50	85	63	55	37	40	40	90	135	. . .
/20	1/20	1/20	1/20	1/20	1/10	1/15	1/20	1/5	1/20	1/5	1/20	1/10	1/5	1/10	1/10	1/10	1/10	. . .
/30	1/30	1/30	1/30	1/30	1/50	1/30	1/60	1/50	1/50	1/50	1/50	1/50	1/20	1/20	1/30	1/50	1/50	. . .
—	—	2	—	6	—	—	4	—	—	—	—	—	—	—	—	—	—	4 . .
—	—	—	3	3	20	—	6	—	—	—	—	—	—	—	—	—	—	6 . .
—	—	1	1	6	—	—	—	—	—	—	3	—	—	—	—	—	—	9 . .
—	3	5	3	11	—	—	3	—	—	—	—	—	—	—	—	-	—	10 . .
—	—	1	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	11 . .
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	16 . .
90	215	70	90	170	490	110	975	30	550	90	305	290	24	440	395	310	85	22 . .
—	—	—	—	—	—	—	14	—	—	—	—	—	—	—	—	—	—	24 . .
8	24	27	45	150	—	3	450	—	—	—	—	—	—	—	—	—	—	25 . .

1

Ancylus uplift

	Klevekilen II	Klevekilen I A		Klevekilen I B				Fossa	Röd			Fjällbacka II			Sörgården	Tången II	Näse I	
	p. 608	p. 608						p. 610	p. 610			p. 611			p. 612	p. 612	p. 61	
. .		1	2	1	2	3	4	1	1	2	3	1	2	3		3	1	2
. .	a. 17	a. 13		a. 13				a. 11	a. 11			a. 10			2	a. 2	a. 5	
. .		12	12.6	11.2	12	12.5	13	10	9	10	10.6	8.5	9.2	10			4	4.
. .	340	250	245	190	235	240	300	260	246	277	185	240	207	244	285	330	205	22
. .	140	65	47	35	53	68	80	48	115	75	90	17	56	126	45	105	90	9
. .	20	80	67	35	65	78	92	50	14	25	26	18	18	62	50	50	52	7
. .	1/4	1/10	1/10	1/15	1/15	1/20	1/10	1/10	1/5	1/5	1/20	1/5	1/10	1/10	1/10	1/5	1/20	1/2
. .	1/20	1/30	1/30	1/30	1/40	1/40	1/40	1/40	1/15	1/20	1/20	1/10	1/10	1/40	1/80	1/30	1/30	1/5
. 1	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	
. 4	2	4	1	—	—	—	—	+	3	—	—	—	—	—	—	+	—	
. 6	2	9	6	—	—	4	—	32	—	—	—	—	—	—	—	—	15	
. 9	—	—	—	—	—	—	—	4	10	—	—	—	—	—	—	—	—	
. 10	4	—	—	—	—	—	—	32	46	—	—	—	—	—	1	—	16	
. 11	1	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	3	
. 12	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	+	—	
. 15	—	—	—	—	—	—	—	—	+	—	—	—	—	—	1	—	—	
. 16	1	1	7	—	1	2	5	—	1	2	1	—	—	1/2	1	+	—	
. 19	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	1	—	
. 21	—	—	—	—	—	—	—	—	—	+	2	—	—	—	—	—	—	
. 22	48	+	—	150	390	330	340	82	290	200	960	18	130	300	20	42	190	2
. 24	4	—	—	—	—	—	1	2	30	8	28	+	1	2	—	—	4	
. 25	13	120	140	—	8	22	30	1 050	10 500	—	—	2	2	75	80	335	455	1 4

. . 668

				Tapes sinking														1
Ellene				Hovenäs III		Slottet II			Tången I			Udden II				Solbräcke		
p. 613				p. 614		p. 615			p. 616			p. 616				p. 617		
1	2	3	4	1	2	1	2	3	1	2	3	1	2	3	4	1	2	. .
a. 4.5				a. 1.5		a. 16			a. 20			a. 27				a. 24		. .
2.3	3 3	3.9	4.5	0.5	0.8	14.5	15.2	16	18.4	19.2	20	24.2	25	25.7	26 5	23.5	24	. .
200	210	224	224	335	345	260	170	235	270	240	290	260	240	295	280	255	285	. .
85	100	80	85	205	170	40	42	50	50	62	105	70	70	70	57	55	75	. .
40	37	37	50	65	100	37	28	50	45	47	87	32	70	90	75	38	42	. .
1/20 1/30	1/20 1/30	1/20 1/30	1/20 1/30	1/5 1/20	1/10 1/20	1/20 1/30	1/20 1/30	1/20 1/40	1/10 1/30	1/10 1/30	1/20 1/50	1/5 1/20	1/20 1/40	1/10 1/40	1/10 1/40	1/10 1/30	1/10 1/40	. . . .
—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—	—	2 .
—	—	6	3	3	1	2	—	2	—	—	—	—	—	2	3	3	7	4 .
—	—	3	21	—	—	12	24	36	—	3	—	—	4	—	—	6	4	6 .
—	—	3	—	—	—	—	—	—	—	—	—	—	10	3	2	2	2	9 .
—	6	28	33	1	1	2	—	8	—	1	1	2	40	27	8	30	45	10 .
—	1	3	5	—	—	1	4	2	—	1	1	—	2	—	—	—	+	11 .
—	—	+	—	+	—	2	4	4	—	—	—	—	—	—	—	5	—	12 .
—	—	—	—	—	1	1	4	1	—	6	1	—	—	—	2	2	2	16 .
—	—	—	—	—	1	3	7	6	—	1	—	—	—	—	—	—	—	19 .
—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21 .
410	350	335	325	10	20	420	195	240	265	420	480	135	660	300	325	185	155	22 .
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	23 .
—	—	4	2	1	2	2	—	—	6	4	15	1	—	+	—	—	—	24 .
—	10	45	345	150	210	130	665	1 540	+	3	47	1	6	100	115	90	245	25 .

669 . .

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Last uplift

	Kårehogen			Fjäll-backa I	Ud-den II	Fiske-bäcks-kil I	Fuglevik					Dal				Fjel	
	p. 618			p. 618	p. 619	p. 619	p. 620					p. 621				p. 62	
. .	1	2	3		5		1	2	3	4	5	1	2	3	4	1	
. .		?		a. 33	a. 27	a. 22			a. 35				a. 34			a. 2	
. .	×	× +0.7	× +1.5				31.5	32.5	33.5	34.5	35	32.5	33	33.5	34	27	
. .	350	285	350	360	255	340	260	265	310	320	320	225	260	280	270	245	
. .	25	35	155	150	160	140	63	50	168	100	180	20	63	37	63	5	
. .	20	42	48	82	50	53	83	85	70	100	67	30	40	35	30	22	
. .	1/5	1/10	1/5	1/5	1/20	1/10	1/10	1/10	1/10	1/10	1/10	1/5	1/10	1/10	1/5	1/5	
. .	1/20	1/30	1/30	1/30	1/20	1/50	1/60	1/60	1/60	1/60	1/50	1/30	1/·0	1/40	1/30	1/20	
. 4	3	—	—	2	2	—	6	+	—	3	—	—	—	—	—	—	
. 6	—	—	—	6	—	5	36	24	36	12	—	45	12	16	12	2	
. 9	—	—	—	—	1	—	18	11	6	—	—	12	22	4	—	—	
. 10	—	5	1	16	7	-—	75	100	45	14	1	150	270	245	13	—	
. 11	—	—	—	—	—	—	2	2	3	+	—	3	4	+	3	—	
. 12	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—	
. 14	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	
. 15	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	
. 16	2	—	—	—	—	—	2	—	+	—	+	—	—	—	2	—	
. 19	3	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	
. 21	—	—	—	—		—	—	—	—	—	—	—	—	—	—	—	
. 22	32	760	265	—	225	—	230	170	180	165	115	9	35	16	18	—	1
. 24	—	6	6	—	1	—	6	1	+	—	1	+	4	—	1	—	
. 25	—	15	190	870	450	2 720	360	310	210	110	150	—	22	105	125	1	1
. .							670										

Last uplift

1

Fjällbacka III				Fintorp II			Fossa	Hestrand II			Hamn I	Kristineberg I		Hovenäs I	Hovenäs II		
p. 622				p. 623			p. 623	p. 624			p. 624	p. 625		p. 626			
1	2	3	4	1	2	3	2	1	2	3		1	2		1	2	. . .
a. 15				a. 17			a. 11	a. 15			a. 10	a. 10		a. 14	a. 13		.
2	13	14	15	16	16.5	17	10.6	13	14	15		9.5	10		12.3	13	. . .
60	200	190	250	315	325	305	300	160	225	300	280	230	246	310	280	270	. . .
10	50	60	105	42	82	54	175	37	75	100	160	96	105	120	22	42	. . .
48	47	42	53	45	62	83	43	43	47	75	28	50	55	40	40	42	. . .
10	1/10	1/10	1/10	1/15	1/20	1/10	1/10	1/10	1/10	1/10	1/10	1/20	1/10	1/10	1/5	1/5	. . .
40	1/40	1/40	1/50	1/40	1/40	1/40	1/40	1/40	1/40	1/50	1/10	1/40	1/40	1/30	1/30	1/30	. . .
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1 .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	+	3 .
+	—	2	8	—	—	—	1	—	—	3	—	—	—	—	—	—	4 .
24	36	36	20	—	—	—	8	20	12	15	—	8	20	—	33	3	6 .
35	35	16	—	—	—	—	—	17	9	5	2	1	4	—	2	1	9 .
30	285	280	55	2	14	11	24	120	140	57	1	5	13	11	37	23	10 .
5	9	1	1	—	1	+	3	1	1	1	3	1	3	1	—	—	11 .
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	12 .
—	—	—	—	—	—	—	—	—	—	—	1	—	+	—	—	—	15 .
+	—	—	—	—	—	—	—	—	2	1	2	2	—	—	—	+	16 .
5	—	—	—	—	+	—	—	—	—	—	1	—	—	—	—	—	19 .
—	—	—	—	6	2	—	—	—	—	—	—	—	—	—	—	—	21
1	14	11	28	255	190	230	60	4	9	88	42	140	135	—	37	33	22 .
5	11	—	—	—	—	—	4	—	—	—	1	4	5	—	1	3	24 .
45	135	700	1 300	1 235	650	380	1 670	865	1 330	1 190	20	165	185	1 635	530	1 140	25 .

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Last uplift

	Klevekilen I A	Fintorp I			Svenneby V	Slottet I	Hestrand I	Näset II	Svenneby							
									VII			I		VI		
	p. 627	p. 627			p. 628	p. 628	p. 628	p. 629	p. 629							
. .	3	1	2	3					1	2	3	1	2	1	2	3
. .	a. 13	a. 8			a. 15	a. 7	a. 12	a. 9	a. 5			a. 8		a. 8		
. .	13	7	7.3	8					3.8	4.4	5	7	8	6.4	7.2	8
. .	240	420	325	315	280	310	285	260	230	245	240	320	390	225	255	25
. .	85	15	30	70	55	130	67	78	72	97	54	165	210	65	105	6
. .	72	20	40	42	125	38	56	47	40	34	48	65	60	38	34	4
.	1/20	1/10	1/15	1/20	1/10	1/5	1/10	1/5	1/10	1/5	1/10	1/10	1/10	1/10	1/10	1/1
. .	1/30	1/20	1/30	1/40	1/80	1/30	1/40	1/40	1/30	1/30	1/30	1/30	1/30	1/40	1/30	1/5
. 4	2	—	—	—	—	10	—	—	3	10	8	—	—	10	15	
. 6	12	18	60	8	8	6	32	36	36	12	3	6	—	36	20	
. 7	—	—	—	—	—	—	—	—	—	6	—	3	18	—	—	
. 8	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	
. 9	—	—	5	17	5	—	—	8	—	—	—	13	17	3	4	
. 10	11	56	185	180	5	3	35	132	7	2	1	40	45	40	95	
. 11	—	1	6	1	1	+	1	2	1	—	1	1	½	+	2	
. 12	—	—	—	—	—	+	—	+	+	+	—	—	—	—	—	
. 13	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	
. 15	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	
. 16	1	—	—	—	—	—	2	6	—	—	—	1½	—	—	—	
. 19	—	—	—	—	—	—	—	—	4	—	1	—	—	+	—	
. 22	495	6	3	10	36	55	132	40	35	43	52	12	8	20	13	
. 24	—	—	3	—	—	+	—	3	+	—	—	—	1	—	1	
. 25	290	510	1 170	1 310	2 515	345	1 420	1 580	645	840	880	1 030	1 065	895	995	1 0
. .							672									

Last uplift

1

ik I	Varpet		Löken	Ålestranden	Groten I		Havik				Slependen	Hermanö II	I A	B	C	
631	p. 631		p. 632	p. 632	p. 632		p. 633				p. 633	p. 634				
	1	2			1	2	1	2	3	4			4	2		. . .
11	a. 20		a. 17	a. 16	a. 20						a. 23	a. 3	a 3.5	a. 3	a. 3	. . .
	19	20			18.8	20	×	× + 0.7	× + 1.5	× + 2.2			3.5	2.5	2.5	. . .
80	215	240	500	245	265	220	225	235	240	265	290	235	275	300	200	. . .
65	47	45	145	25	110	100	43	70	38	28	180	140	85	100	100	. . .
35	58	60	40	40	42	68	87	70	70	96	32	35	60	43	22	. . .
/10	1/10	1/10	1/3	1/5	1/10	1/20	1/10	1/10	1/10	1/10	1/10	1/5	1/20	1/15	1/10	. . .
/30	1/50	1/50	1/20	1/30	1/40	1/60	1/50	1/60	1/60	1/70	1/20	1/30	1/50	1/20	1/20	. . .
—	—	+	—	—	—	—	—	—	—	—	—	—	—		—	3 . .
10	—	3	2	2	—	—	—	—	—	—	3	2	—	1	1	4 . .
—	130	95	34	6	12	12	10	24	6	14	4	9	5	8	—	6 . .
—	30	55	—	—	+	8	17	14	10	6	—	—	—	—	2	9 . .
—	220	275	—	—	25	45	115	170	120	65	2	12	1	—	10	10 . .
—	3	3	—	—	—	—	+	—	1	+	—	2	—	—	1	11 . .
—	16	+	+	—	+	—	—	—	—	—	1	—	—	—	—	12 . .
—	—	—	—	—	—	+	—	—	—	—	1	—	—	—	1	15 . .
—	8	—	1	2	2	+	—	—	3	+	+	—	—	1	1	16 . .
—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	20 . .
—	+	—	—	—	2	—	—	—	—	—	—	—	—	—	—	21 . .
3	275	255	+	4	120	430	60	45	70	30	2	10	505	225	47	22 . .
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	+	24 . .
10	385	835	170	650	95	220	780	925	865	805	480	1 540	6	430	280	25 . .

673

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Last uplift

	Grundsund		Näset I	Rörvik I	Rörvik II	Vik IV	Florö	Hamn II		Tryggö		Hunnebo	Ålstenshamn I			II.
	p. 635		p. 636	p. 636		p. 637	p. 637	p. 638		p. 638		p. 638	p. 639			
. .	1	2	3					1	2	1	2		1	2	3	
. .	1.5		a. 5	a. 9	5–10	1	5–10	a. 7		a. 3		1.5	a. 4			a.
. .	1	1.5	4.7					6	7	2	3		2.8	3.4	4	
. .	300	265	235	345	270	325	325	275	300	265	295	245	225	230	335	36
. .	155	95	135	145	62	140	93	100	58	53	175	75	35	95	180	15
. .	48	52	40	60	47	53	60	50	75	34	30	70	75	60	70	3
. .	1/5	1/10	1/10	1/5	1/10	1/10	1/5	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/10	1/1
. .	1/40	1/40	1/30	1/30	1/40	1/30	1/50	1/40	1/50	1/30	1/30	1/50	1/60	1/50	1/50	1/
. 4	4	9	1	1	3	6	—	2	3	3	3	1	—	—	—	-
. 5	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	-
. 6	8	4	9	3	4	—	5	—	—	9	9	10	18	15	—	-
. 7	—	—	—	—	—	—	5	—	—	—	—	5	—	—	—	
. 9	—	—	—	—	—	—	3	-	—	25	1	—	2	2	—	-
. 10	—	—	4	1	6	—	4	—	3	125	18	—	27	55	15	-
. 11	—	—	3	—	—	—	+	—	—	2	3	—	+	1	—	-
. 16	+	—	—	—	—	—	+	+	—	—	—	—	—	—	—	
. 20	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	
. 21	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	
. 22	24	15	42	18	36	57	2	10	115	35	15	6	12	—	—	
. 24	+	+	—	1	—	—	—	—	—	1	—	—	—	—	+	
. 25	2 070	2 670	920	390	1 060	95	630	440	995	590	340	1 550	1 500	1 050	2 500	3

. . 674

Last uplift

1

öd- rug II		Gro- ten II		Öde- gården		Lavö- sund I	Hove- näs III	Sven- neby II	Vik II		Vike- kilen I		Sven- neby IV	Ål- stens- hamn II	
640		p. 641		p. 641		p. 642	p. 642	p. 642	p. 643		p. 643		p. 644	p. 644	
		1	2	1	2		3		1	2	1	2		1	. . . .
15	a. 14	a. 8		10–15		1.8	1.5	3	1		1.3		1.5	0.4	. . . .
		7	8	×	× +0.8	1.3	1.2		0.5	1	0.6	1.3		–0.2	. . . .
)	260	230	255	380	333	340	265	320	295	225	335	340	310	255	. . . .
7	100	66	120	100	70	166	160	58	90	50	110	125	25	60	. . . .
7	75	38	28	77	70	38	32	48	45	40	100	85	70	85	. . . .
	1/10	1/10	1/10	1/10	1/10	1/5	1/10	1/5	1/10	1/10	1/10	1/10	1/10	1/20	. . . .
0	1/30	1/40	1/30	1/30	1/30	1/20	1/10	1/20	1/40	1/40	1/40	1/40	1/40	1/50	. . . .
5	1	—	5	—	—	3	—	—	11	18	—	2	2	8	4 . . .
5	70	4	18	—	12	—	—	—	—	—	16	—	—	30	6 . .
—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	7 . .
—	3	—	+	—	—	—	—	1/2	—	—	1	—	3	1	9 . .
—	16	—	8	—	1	—	—	4	7	—	7	3	25	17	10 . .
—	1	—	1	—	—	+	—	—	2	—	1	—	—	1	11 . .
—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	12 . .
2	—	+	—	—	—	—	—	—	+	—	2	1	—	1	16 . .
—	—	—	3	—	—	—	—	—	+	—	—	—	—	1	19 . .
—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	21 . .
6	+	18	70	9	37	—	1	25	125	70	15	55	60	175	22 . .
—	—	—	+	—	—	—	—	—	4	—	—	—	4	—	24 .
0	535	14	180	100	685	205	20	170	1 080	1 450	670	1 900	935	2 000	25 . .

675

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1

Modern

	Smalsundet			Kristineberg II					Fiske-bäcks-kil II	Her-manö III	Ål-stens-hamn II	Vik III	Vike-kilen	
	A	B	C	A	B	C	D	E					II	I
. .	p. 499			p. 501					p. 503	p. 504	p. 505	p. 505	p. 506	
. .	–1	–0.5	0	0.75	0.6	0.3	0.1	0	–0.2	0	0.4	0	0	(
. .														
. .	265	545	215	330	265	330	230	375	335	370	255	360	380	4
. .	135	325	105	37	160	52	200	205	185	85	30	30	105	2
. .	20	3	33	77	56	60	22	30	14	100	100	125	80	
. .	1/10	1/2	1/10	1/10	1/20	1/10	1/10	1/10	1/5	1/10	1/10	1/10	1/10	1
. .	1/20	1/4	1/30	1/30	1/30	1/50	1/20	1/10	1/5	1/40	1/50	1/50	1/40	1/
. 3	—	—	—	—	—	1	—	—	—	—	—	—	—	
. 4	—	+	—	6	2	—	—	1	—	—	1	—	2	-
. 6	4	—	—	3	—	—	—	—	—	—	—	—	—	
. 9	—	—	—	—	—	—	—	—	—	2	—	—	—	-
. 10	2	—	20	13	26	11	15	2	—	45	3	15	12	
. 11	—	+	—	—	2	—	—	—	—	—	—	—	—	-
. 15	—	—	—	—	—	—	—	—	—	1	—	—	—	-
. 16	—	—	—	—	—	2	—	-	—	—	—	—	1	-
. 19	—	—	—	—	3	4	3	—	—	—	—	—	—	-
. 22	6	2	19	85	265	320	135	105	—	60	260	220	66	1
. 24	1	—	7	+	8	1	14	—	—	25	+	—	—	-
. 25	610	16	1 610	645	1 400	320	500	110	22	2 100	2 440	1 610	600	5

. . 676

Modern

1

Svenneby III		Skarvik	Strömsund	Bärviken	Lindholmen		Humlesäcken	Flatholmen		Gåsöredd				Gullmaren				
A	B				I	II		I	II	I	II	III	IV					
p. 506		p. 507	p. 509	p. 510	p. 510		p. 511	p. 513		p. 514				p. 517		Number of samples		
0	0	0	–5	–15	–15	–15 to –20	–25 to –30	–30	–30	–30	–30 to –40	–30	–30	–60 to –80		Locality: Height in m above sea level		
																Samples: »		
20	455	345	320	315	225	195	295	225	228	190	265	240	220	255		Weight in gr of whole sample, 0.2 dm^3		
05	155	225	274	255	190	120	204	195	120	162	170	212	208	230		» material 2 < mm		
23	54	67	18	18	14	26	?	22	36	3	12	7	6	18		» » 1—2 mm		
/5	1/10	1/10	1/10	1/10	1/10	1/10	1/20	1/20	1/10	1/10	1/10	1/10	1/20	1/20		Analyzed part of dm^3 of material 2 < mm		
/40	1/20	1/25	1/5	1/10	1/10	1/20	1/10	1/20	1/30	1/5	1/10	1/10	1/10	1/20		» 1—2 mm		
																1 *Abra alba*	b^{m}l	d
																2 » *longicallis*	b^{m}l	d
—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	3	3 » *nitida*	bl	d
—	—	—	—	+	5	4	—	+	—	+	1	+	+	2	4	4 » sp.		
																5 *Alvania lactea*	bl^l	s
—	—	—	—	—	11	6	21	18	70	1	1	5	—	2	6	6 » *punctura*	bl	d
—	—	—	—	—	3	6	1	8	12	—	—	—	—	—	7	7 » *reticulata*	bl^l	d
																8 » *zetlandica*	b^{m}l	d
2	—	—	+	—	4	4	6	6	11	—	—	4	+	4	9	9 *Anomia aculeata*	a^{l}bl	sd
10	1	2	—	—	10	25	15	14	19	—	22	28	14	3	10	10 » *ephippium*	a^{l}bl	sd
1/2	—	1	—	—	—	5	2	6	3	2	3	9	7	+	11	11 » *patelliformis-striata*	b^{m}l	d
—	+	+	—	2	—	—	4	2	+	1	+	2	—	+	12	12 *Aporrhais pes pelicani*	bl	d
																13 *Arcinella plicata*	b^{m}l	d
																14 *Astarte borealis*	ab^h	d
—	—	1	—	—	—	—	—	4	1	—	—	—	—	—	15	15 » *elliptica*	ab	d
—	—	2	3	3	2	1	4	9	7	1	3	1	1	4	16	16 » *montagui*	ab	d
—	—		—	—	—	—	+	+	1	—	—	—	—	1	17	17 » *sulcata*	a^{l}bl	d
—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	18	18 *Atys utriculus*	bl^l	d
—	—	—	—	—	1	1	3	1	+	—	+	1	1	—	19	19 *Axinus flexuosus*	w	d
																20 » *sarsi*	b	d
																21 » sp.		
23	16	36	32	35	75	125	17	2	5	—	70	67	38	14	22	22 *Balanus crenatus*	w	sd
																23 » *hameri*	a^{l}b	d
1	—	6	7	+	25	25	16	38	36	3	22	28	8	16	24	24 » *porcatus*	ab	d
330	250	1 000	82	8	23	53	95	30	30	8	5	10	3	310	25	25 *Bittium reticulatum*	bl^l	sd

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Continued on page

2

Continued from page 654

					Ancylus sinking						Ancylus uplift									
					Gude-bo	Skårbo			Knuts-dalen		Bred-hult		Skär-je-dalen	Ox-torp	Ullerö	Tose			Häst käll
					p. 598	p. 599			p. 600		p. 600		p. 601	p. 602	p. 603	p. 604			p. 60
			Number of samples			1	2	3	1	2	1	2				1	2	3	
			Height »		46.3	44.2	45.2	46	53	54	70	71	63	49	59	55.8	56.4	57	33.5
ab	sd	1	*Boreochiton marmoreus*	1	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—
ab	d	2	» *ruber*	2	—	—	—	—	—	—	—	—	½	—	—	—	—	—	—
a	sd	3	*Buccinum groenlandicum*																
ab	d	4	» *undatum*	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
$b^{l}l$	d	5	*Callochiton laevis*																
bl	d	6	*Capulus hungaricus*																
bl	d	7	*Cardium echinatum*																
bl	s	8	» *edule*	8	1	—	—	—	—	4	—	—	—	—	—	—	—	+	2
bl	sd	9	» *exiguum*	9	—	—	—	—	—	—	—	—	3	3	—	—	—	—	—
$a^{l}bl$	d	10	» *fasciatum*	10	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—
bl	d	11	» *minimum*	11	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
bl	d	12	» *nodosum*																
$b^{l}l$	d	13	» *norvegicum*	13	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—
		14	» sp.																
$b^{l}l$	sd	15	*Cerithiopsis tubercularis*																
bl	d	16	*Chiton hanleyi*																
bl	d	17	*Clathurella linearis*	17	—	1	—	—	—	—	—	—	1	—	—	—	—	—	—
$b^{l}l$	d	18	*Coecum glabrum*																
$b^{m}l$	d	19	*Conulus millegranus*																
bl	sd	20	*Corbula gibba*																
bl	d	21	*Crania anomala*																
bl	s	22	*Craspedochilus marginatus*	22	—	+	—	—	—	—	—	—	1	—	—	—	—	—	—
$b^{m}l$	d	23	*Cultellus pellucidus*																
$a^{l}bl$	sd	24	*Cyamium minutum*																
ab	d	25	*Cylichna alba*																
$a^{l}b$	d	26	*Cyprina islandica*																
$a^{l}bl$	d	27	*Dentalium entale*																
w	d	28	*Diaphana hyalina*																
$b^{l}l$	sd	29	*Dosinia exoleta*																
$b^{m}l$	d	30	» *lincta*																
bl	sd	31	*Emarginula fissura*																

Continued on page 678

Ancylus uplift
655

2

	Udden I				Lavö			Fyka					Lersten					
	p. 605				p. 605			p. 606					p. 607					
	2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	4	5	. . . .
3	34	35	35.5	36	18	19	20	20.2	21	21.7	22.5	23	15	16	17	18	19	. . . .
+	+	—	+	—	—	—	2	—	1	—	1	—	+	—	+	—	—	2 . . .
—	—	—	—	—	+	5	15	—	—	—	—	—	—	1	—	—	—	9 . . .
—	—	—	—	—	—	—	6	—	—	—	—	—	—	$^1/_2$	—	—	—	10 . . .
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	12 . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	1	$^1/_2$	2	—	—	14 . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	17 . . .
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	20 . . .
+	1	+	+	+	—	—	—	—	—	—	—	—	—	—	—	—	—	22 . . .
—	—	—	—	—	—	—	12	—	—	—	—	—	—	—	—	—	—	24 . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	28 . . .

2

Ancylus uplift

656

	Klevekilen II	Klevekilen I A		Klevekilen I B				Fossa	Röd			Fjällbacka II			Sörgården	Tången II	Näset	
	p. 608	p. 608						p. 610	p. 610			p. 611			p. 612	p. 612	p. 612	
. .		1	2	1	2	3	4	1	1	2	3	1	2	3		3	1	2
. .	17	12	12.6	11.2	12	12.5	13	10	9	10	10.6	8.5	9.2	10	2	2	4	4.
. 1	+	1	—	—	—	—	—	2	+	—	—	—	—	—	—	—	—	—
. 2	—	1	1	—	—	2	—	—	+	1	—	—	—	—	—	1	4	5
. 4	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. 8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
. 9	—	—	—	—	—	—	1	4	—	1	—	—	—	—	—	1	1	5
. 10	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—
. 12	—	7	3	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
. 14	—	—	—	—	1	2	—	—	—	—	—	—	—	—	—	—	—	—
. 17	—	—	—	—	—	4	4	—	30	—	—	—	—	—	—	—	3	—
. 18	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—
. 20	—	7	4	—	2	1	3	9	8	—	—	—	—	—	4	18	—	3
. 22	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	2
. 24	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5	5	5
. 26	—	—	—	—	—	—	—	—	+	1/2	—	—	—	—	—	—	—	—
. 28	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—
. 30	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
. 31	—	—	—	—	—	—	—	—	—	—	—	—	—	1	+	—	—	—

680

Tapes sinking
657

2

Ellene				Hovenäs III		Slottet II			Tången I			Udden II				Solbräcke		
p. 613				p. 614		p. 615			p. 616			p. 616				p. 617		
1	2	3	4	1	2	1	2	3	1	2	3	1	2	3	4	1	2	. .
2.3	3.3	3.9	4.5	0.5	0.8	14.5	15.2	16	18.4	19.2	20	24.2	25	25.7	26.5	23.5	24	. .
—	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	—	—	1 .
—	—	3	10	—	—	2	5	9	—	—	1	+	1	+	—	4	3	2 .
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	7 .
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	+	8 .
—	—	—	1	1	2	—	12	12	—	—	1	—	—	—	2	+	2	9 .
—	—	—	—	—	—	12	27	14	—	—	—	—	—	1	—	1	—	10 .
—	—	—	8	—	—	—	1	10	—	—	—	—	—	23	8	—	—	12 .
—	—	—	—	—	8	—	—	—	—	—	—	—	—	—	—	—	—	14 .
—	—	—	3	—	—	9	6	2	—	—	—	—	—	—	—	—	—	17 .
—	—	2	7	1	2	3	12	17	—	1	1	—	—	—	2	—	+	20 .
—	—	—	—	—	—	—	—	—	—	—	—	—	+	+	—	1	1	22 .
—	—	—	—	—	—	2	—	2	—	—	—	—	—	—	—	—	—	24 .
—	—	—	—	—	—	—	2	2	—	—	—	—	—	—	—	—	—	25 .
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	+	26 .
—	—	—	—	1	+	—	—	—	—	—	+	—	—	—	—	—	—	31 .

681

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2

Last uplift

658

	Kårehogen			Fjäll-backa I	Ud-den II	Fiske-bäcks-kil I	Fuglevik					Dal				Fjel	
	p. 618			p. 618	p. 619	p. 619	p. 620					p. 621				p. 62	
. .	1	2	3		5		1	2	3	4	5	1	2	3	4	1	
. .	×	× + 0.7	× + 1.5	33	27	22	31.5	32.5	33.5	34.5	35	32.5	33	33.5	34	27	
. 1	—	—	—	—	—	—	—	—	—	—	—	+	—	1	+	+	
. 2	+	—	—	—	+	+	2	3	2	3	5	3	4	3	3	—	
. 4	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—
. 6	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
. 8	—	—	—	—	—	—	—	4	+	+	2	—	—	—	—	—	—
. 9	—	—	7	10	—	46	42	13	6	18	3	3	4	—	—	—	—
. 10	2	—	—	—	—	—	6	+	—	6	—	18	12	+	4	1	
. 12	—	—	—	15	¹/₂	2	—	—	2	—	—	—	—	—	—	—	—
. 17	—	—	—	—	1	—	—	6	1	—	—	—	1	—	+	2	—
. 20	1	3	+	—	—	—	5	7	1	6	6	—	—	4	2	—	
. 22	—	—	—	1	+	1	—	—	—	—	—	—	—	—	—	—	—
. 26	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—
. 31	—	—	—	—	—	—	+	—	—	+	—	+	—	—	—	—	—

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Last uplift

659

2

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	Fjällbacka III			Fintorp II			Fossa	Hestrand II			Hamn I	Kristineberg I		Hovenäs I	Hovenäs II		
	p. 622			p. 623			p. 623	p. 624			p. 624	p. 625		p. 626			
-	2	3	4	1	2	3	2	1	2	3		1	2		1	2	. . .
2	13	14	15	16	16.5	17	10.6	13	14	15	10	9.5	10	14	12.3	13	. . .
-	2	—	—	—	—	—	+	—	1	2	—	—	—	—	—	—	1 . .
4	5	6	2	3	—	1	3	1	1	+	—	—	+	—	2	—	2 . .
-	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	4 . .
-	—	—	2	4	8	5	—	—	—	2	—	—	—	—	—	—	8 . .
-	4	16	10	—	7	4	8	—	4	10	—	—	2	—	9	8	9 . .
5	2	3	—	—	—	—	+	—	—	—	2	—	—	—	—	—	10 . .
-	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—	11 . .
-	—	—	2	—	—	—	—	—	5	1	—	—	—	1	4	15	12 . .
-	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	13 . .
1	—	4	—	—	—	—	—	—	—	6	1	—	—	—	—	—	17 . .
-	—	—	1	1	+	+	8	—	4	3	2	—	—	—	—	2	20 . .
-	—	—	+	—	—	—	—	—	1	—	—	+	—	+	—	—	22 . .
-	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	2	24 . .
-	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	27 . .
-	1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	31 . .

683

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2

Last uplift

660

	Klevekilen I A p. 627	Fintorp I p. 627			Svenneby V p. 628	Slottet I p. 628	Hestrand I p. 628	Näset II p. 629	Svenneby VII p. 629			Svenneby I		Svenneby VI	
. .	3	1	2	3					1	2	3	1	2	1	2
. .	13	7	7.3	8	15	7	12	9	3.8	4.4	5	7	8	6.4	7.2
. 1	—	—	—	—	—	—	—	—	—	1	—	—	—	—	+
. 2	1	2	10	6	4	+	4	1	2	3	2	2	6	3	5
. 5	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—
. 8	3	—	—	—	—	—	5	—	—	—	—	—	—	+	—
. 9	—	—	6	2	1	6	20	22	8	11	11	—	—	30	15
. 10	—	2	—	1	—	1	—	—	—	—	—	—	—	2	3
. 12	—	1	—	3	—	—	2	6	3	—	—	4	15	—	—
. 13	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—
. 14	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. 17	—	1	12	—	—	—	4	4	—	3	—	3	3	1	—
. 20	2	1	—	—	—	16	3	+	8	5	3	—	—	12	5
. 22	1	—	+	+	3	—	—	1	—	—	—	—	—	—	1
. 24	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. 26	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
. 27	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
. 31	—	+	—	—	—	+	—	—	—	+	+	—	—	+	—

.

684

Last uplift

661

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ik I	Varpet		Lökken	Ålestranden	Groten I		Havik				Slependen	Hermanö II	I A	B	C	
31	p. 631		p. 632	p. 632	p. 632		p. 633				p. 633	p. 634				
	1	2			1	2	1	2	3	4			4	2		. . .
1	19	20	17	16	18.8	20	×	× + 0.7	× + 1.5	× + 2.2	23	3	3.5	2 5	2.5	. . .
—	2	3	1	—	+	+	—	2	1	—	—	—	—	1	—	1 . .
+	5	9	3	+	1	3	6	5	2	5	1	—	—	1	+	2 . .
—	—	—	—	—	—	2	—	—	—	—	1	—	—	—	—	6 . .
—	—	—	1/2	—	—	—	—	—	—	—	—	—	—	—	—	7 . .
—	—	—	+	—	—	—	—	—	—	—	—	+	—	2	1	8 . .
2	—	6	4	5	+	6	7	28	48	22	3	27	—	3	5	9 . .
—	40	70	—	5	3	—	—	—	+	2	4	—	—	—	—	10 . .
—	3	6	10	—	—	—	—	—	—	—	—	—	—	—	—	11 . .
—	—	—	—	—	6	10	26	40	27	11	—	+	—	—	—	12 . .
—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	1	13 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	11	5	14 . .
—	10	6	8	6	—	—	—	1	—	7	4	—	—	—	—	17 . .
—	12	27	20	7	—	—	—	+	+	4	1	9	—	6	3	20 . .
—	—	—	—	—	—	—	3	2	8	+	—	+	+	+	1	22 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—	24 . .
—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	25 . .
—	—	—	1/2	—	—	—	—	—	—	—	—	—	—	2	1	26 . .
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	27 . .
—	—	—	—	—	—	—	5	—	—	—	—	—	—	—	—	28 . .
—	+	+	1	1	1	2	1	2	—	—	1	—	—	—	—	31 . .

685

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2

Last uplift

662

	Grund-sund		Näset I	Rörvik		Vik IV	Florö	Hamn II		Tryggö		Hun-nebo	Ålstensham		
				I	II								I		
	p. 635		p. 636	p. 636		p. 637	p. 637	p. 638		p. 638		p. 638	p. 639		
. . .	1	2	3	—	—	—		1	2	1	2		1	2	3
. . .	1	1.5	4.7	9	5–10	1	5–10	6	7	2	3	1.5	2.8	3.4	4
. . 1	+	1	—	—	1	—	—	—	—	1	—	1	—	+	—
. . 2	—	—		—	—	—	1	—	+	3	+	7	2	2	—
. . 7	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
. . 9	8	13	4	3	5	—	3	—	3	22	7	7	3	—	—
. 12	1	—	—	—	—	—	—	—	—	3	3	1	1	—	—
. 13	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—
. 17	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. 20	1	3	—	3	16	57	—	5	4	—	—	5	—	—	—
. 22	—	—	+	—	—	—	—	—	—	—	—	—	+	—	+
. 24	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—
. 26	—	—	—	+	—	1	—	—	—	—	—	—	—	—	—
. 29	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—
. 31	—	—	—	—	—	+	+	—	—	—	—	—	—	—	1

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686

Last uplift

663

2

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	dbrug II	Groten II		Öde-gården		Lavö-sund I	Hove-näs III	Sven-neby II	Vik II		Vike-kilen I		Sven-neby IV	Ålstens-hamn II	
. 640		p. 641		p. 641		p. 642	p. 642	p. 642	p. 643		p. 643		p. 644	p. 644	
		1	2	1	2		3		1	2	1	2		1	. . . .
15	14	7	8	×	× + 0.8	1.3	1.2	3	0.5	1	0.6	1.3	1.5	–0.2	. . . .
-	1	—	—	—	—	—	—	—	—	—	1	—	—	—	1 . . .
-	5	1	3	—	+	—	—	1	1	+	+	—	4	12	2 . . .
-	—	—	—	—	—	—	—	-	—	—	1	—	—	—	3 . . .
-	—	—	—	—	—	—	—	—	—	—	—	—	—	+	5 . . .
-	—	—	--	1	-	—	—		—	—	—	—	—	—	6 . . .
-	—	—	—	—	—	—	—	—	+	—	—	—	—	—	7 . . .
-	—	—	—	+	2	—	—	—	—	—	—	—	13	9	8 . . .
2	—	—	9	—	6	5	—	—	2	12	1	4	2	—	9 . . .
3	3	4	7	+	3	—	—	—	2	5	5	—	—	—	10 . . .
-	+	—	—	—	—	—	—	—	—	—	—	—	—	—	12 . . .
-	3	—	—	5	—	+	2	—	—	—	—	—	—	—	14 . . .
-	11	—	2	—	—	—	—	—	4	—	—	—	—	—	17 . . .
3	2	2	7	10	16	2	—	—	42	44	1	1	—	5	20 . . .
-	—	—	—	—	+	—	—	—	—	—	—	—	—	—	22 . . .
-	—	—	+	—	—	—	—	—	—	—	—	—	—	—	26 . . .
-	—	—	1	—	—	—	—	—	—	—	—	—	—	—	27 . . .
.	3	1	+	—	1	—	—	—	1	1	—	—	+	—	31 . . .

687

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Modern

664

	Smalsundet			Kristineberg II					Fiskebäckskil II	Hermanö III	Ålstenshamn II	Vik III	Vikekilen
	A	B	C	A	B	C	D	E					II
. .	p. 499			p. 501					p. 503	p. 504	p. 505	p. 505	p. 506
. .	-1	-0.5	0	0.75	0.6	0.3	0.1	0	-0.2	0	0.4	0	0
. 1	—	—	—	—	+	—	—	—	—	—	—	—	—
. 2	—	—		3	+	—	1	—	—	2	—	—	—
. 8	—	—	23	8	6	2	15	1	22	4	—	—	4
. 9	2	—	—	—	—	—	—	—	—	5	—	—	—
. 12	—	—	—	—	—	—	—	—	—	1	5	—	—
. 17	—	—	3	3	—	5	—	—	—	8	—	—	4
. 20	3	+	1	4	2	5	14	3	—	—	4	1	1
. 22	1	1	2	—	—	1	—	+	—	—	—	—	—
. 27	—	—	—	—	—	—	—	1	—	—	—	—	—
. 31	1	—	—	—	5	—	1	—	—	1	+	+	—

. . . 688

Modern

665 . . . . Continued from page

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venne-by III		Skar-vik	Ström-sund	Bär-vi-ken	Lind-holmen		Hum-le-säcken	Flat-holmen		Gåsöredd				Gull-maren				
	B				I	II		I	II	I	II	III	IV					
p. 506		p. 507	p. 509	p. 510	p. 510		p. 511	p. 513		p. 514				p. 517		Number of samples		
	0	0	-5	-15	-15	-20	-30	-30	-30	-30	-35	-30	-30	-70		Height ›		
—	—	1	—	—	—	—	+	—	1	—	—	—	—	—	1	1 *Boreochiton marmoreus*	ab	sd
—	1	—	—	—	—	—	+	+	1	+	+	+	+	1	2	2 › *ruber*	ab	d
																3 *Buccinum groenlandicum*	a	sd
—	—	—	1	1	1	—	+	—	3	2	+	1	—	—	4	4 › *undatum*	ab	d
																5 *Callochiton leavis*	$b^{l}l$	d
																6 *Capulus hungaricus*	bl	d
—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	7	7 *Cardium echinatum*	bl	d
3	5	—	—	—	—	—	1	1	—	—	—	—	—	—	8	8 › *edule*	bl	s
—	1	2	4	1	—	4	6	—	27	—	9	1	1	4	9	9 › *exiguum*	bl	sd
—	—	—	—	—	9	12	—	13	15	—	—	6	2	—	10	10 › *fasciatum*	$a^{l}bl$	d
																11 › *minimum*	bl	d
																12 › *nodosum*	bl	d
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	13	13 › *norvegicum*	$b^{l}l$	d
																14 › sp.		
—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	15	15 *Cerithiopsis tubercularis*	$b^{l}l$	sd
—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	16	16 *Chiton hanleyi*	bl	d
—	—	—	—	—	2	3	1	4	10	—	1	—	—	6	17	17 *Clathurella linearis*	bl	d
																18 *Coecum glabrum*	$b^{l}l$	d
—	—	—	—	—	—	—	—	10	1	—	—	—	—	—	19	19 *Conolus millegranus*	$b^{m}l$	d
—	1	1	1	18	3	6	4	4	4	2	12	4	17	10	20	20 *Corbula gibba*	bl	sd
—	—	—	—	—	—	—	—	4	2	—	1	1	—	3	21	21 *Crania anomala*	bl	d
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	22	22 *Craspedochilus marginatus*	bl	s
—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	23	23 *Cultellus pellucidus*	$b^{m}l$	d
																24 *Cyamium minutum*	$a^{l}bl$	sd
																25 *Cylichna alba*	ab	d
—	—	—	—	1	—	—	+	—	—	—	+	—	1	—	26	26 *Cyprina islandica*	$a^{l}b$	d
—	—	—	—	—	1	—	1	4	—	1	1	1	2	10	27	27 *Dentalium entale*	$a^{l}bl$	d
																28 *Diaphana hyalina*	w	d
																29 *Dosinia exoleta*	$b^{l}l$	sd
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	30	30 › *lincta*	$b^{m}l$	d
+	+	—	—	—	2	4	5	8	8	2	—	2	—	4	31	31 *Emarginula fissura.*	bl	sd

689 . . . . Continued on page

3

Continued from page 666

					Ancylus sinking						Ancylus uplift									
					Gudebo	Skårbo			Knutsdalen		Bredhult		Skärjedalen	Oxtorp	Ullerö	Tose			Häst käll
					p. 598	p. 599			p. 600		p. 600		p. 601	p. 602	p. 603	p. 604			p. 60
			Number of samples			1	2	3	1	2	1	2				1	2	3	
			Height »		46.3	44.2	45.2	46	53	54	70	71	63	49	59	55.8	56.4	57	33.
bl	d	1	*Eulima bilineata*	1	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—
b^{ml}	d	2	» *distorta*																
b^{ll}	d	3	» *polita*																
b^{ll}	d	4	*Eulimella acicula*																
b^{ml}	d	5	» *ventricosa*																
bl	sd	6	*Gibbula cineraria*	6	—	2	2	—	3	—	—	—	3	3	+	30	—	6	—
$a^{l}bl$	d	7	» *tumida*																
b^{ll}	d	8	*Hinnites pusio*																
b	s	9	*Hydrobia minuta*	9	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—
$a^{l}bl$	s	10	» *ulvae*	10	35	—	—	—	—	5	—	—	—	3	21	—	1	25	—
bl	d	11	*Kellia suborbicularis*																
$a^{l}bl$	s	12	*Lacuna divaricata*	12	—	17	8	10	26	5	75	21	190	6	4	475	118	16	—
$a^{l}bl$	s	13	» *pallidula*	13	—	—	—	—	—	—	—	—	—	—	—	1	5	—	—
b^{ll}	s	14	» *puteolus*																
b^{ll}	sd	15	*Lasaea rubra*																
ab	d	16	*Leda minuta*																
ab	d	17	*Lepeta caeca*	17	1	5	—	—	$^1/_2$	—	—	1	—	—	—	—	—	—	—
$a^{l}bl$	d	18	» *fulva*	18															
bl	d	19	*Lepidopleurus asellus*	19	—	—	—	—	+	—	—	—	2	—	—	—	—	—	—
b^{ll}	d	20	*Lepton nitidum*	20	—	—	—	—	—	—	—	—	3	2	—	2	3	—	—
b^{ml}	d	21	*Lima loscombi*																
		22	» sp.																
$a^{l}bl$	s	23	*Littorina littorea-rudis*	23	19	—	9	21	5	+	—	—	77	52	150	140	240	315	4
$a^{l}bl$	s	24	» *obtusata*	24	1	—	—	—	—	—	—	—	—	3	—	—	—	—	
ab	d	25	*Lophyrus albus*	25	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
bl	d	26	*Lucina borealis*																
b^{ll}	d	27	» *spinifera*																
bl	d	28	*Lucinopsis undata*																
b^{ml}	sd	29	*Lunatia intermedia*	29	—	—	—	—	—	—	—	—	5	—	—	4	—	—	—
b^{ml}	d	30	*Lyonsia norvegica*																
$a^{l}bl$	s	31	*Macoma baltica*	31	—	—	—	—	—	1	—	—	—	—	—	—	—	—	
abm	d	32	» *calcaria*																

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Ancylus uplift
667

3

Udden I				Lavö			Fyka					Lersten					
p. 605				p. 605			p. 606					p. 607					
2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	4	5	. . . .
34	35	35.5	36	18	19	20	20.2	21	21.7	22.5	23	15	16	17	18	19	. . .
3	—	—	4	3	—	36	—	+	—	—	5	8	+	—	—	—	6 . . .
—	—	—	—	—	—	12	—	—	—	—	—	—	—	3	—	—	10 . . .
9	5	46	38	277	30	32	—	105	5	47	36	68	88	64	—	—	12 . . .
—	—	3	—	—	—	—	—	—	—	—	5	—	—	—	—	—	13 . . .
—	—	—	—	—	—	—	—	—	—	—	—	2	1	—	—	—	17 . . .
—	—	—	—	—	—	—	—	—	—	—	—	1	+	+	—	—	19 . . .
2	—	—	—	—	—	—	—	—	—	3	—	1	2	—	—	—	20 . . .
6	4	11	8	42	36	160	—	5	—	17	21	6	12	11	30	4	23 . . .
—	3	—	—	—	—	—	—	—	—	—	—	—	—		—	—	24 . . .
—	—	—	—	—	—	—	—	—	—	—	—	1/2	3	1	—	1	29 . . .
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	31 . . .

3

Ancylus uplift

668

	Klevekilen							Fossa	Röd			Fjällbacka II			Sörgården	Tången II	Näse
	II	I															
		A		B													
	p. 608	p. 608						p. 610	p. 610			p. 611			p. 612	p. 612	p. 6
. . . .		1	2	1	2	3	4	1	1	2	3	1	2	3		3	1
. . . .	17	12	12.6	11.2	12	12.5	13	10	9	10	10.6	8.5	9.2	10	2	2	4
. . 2	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. . 6	1	5	5	—	9	+	5	9	105	—	—	—	1	13	7	1	42
. . 7	1	1	—	—	—	—	—	—	—	8	14	—	—	—	—	—	—
. . 8	1	—	—	—	—	—	—	—	—	—	1/2	—	—	—	—	—	—
. . 10	—		—	—	—	4	—	—	—	—	—	—	—	—	—	3	—
. . 11	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. . 12	4	12	30	—	16	44	44	220	15	10	16	—	—	17	36	—	100
. . 13	—	3	—	—	—	—	—	14	30	—	—	—	—	4	—	4	4
. 15	—	2	—	—	—	1	2	—	—	—	—	—	—	—	—	5	—
. . 16	—	—	—	—	—	—	—	—	+	+	—	—	—	—	—	—	—
. . 17	—	—	—	—	—	—	—	—	2	—	1	—	—	—	—	—	—
. . 19	1	1	1	—	+	1	—	—	2	1	2	—	—	—	—	—	—
. . 20	—	8	2	—	4	4	4	—	—	—	—	—	—	2	3	—	2
. . 23	+	11	13	1	56	42	49	36	1	—	+	1	5	44	22 +	60	50
. . 24	—	—	—	—	—	—	3	—	20	—	—	—	—	—	—	—	5
. . 26	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	1	—
. . 29	2	4	7	—	—	—	17	8	60	—	2	—	—	1	—	4	8
. . 32	—	—	—	—	—	—	—	—	—	1/2	1	—	—	—	—	—	—

692

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Tapes sinking
669

3

Ellene			Hovenäs III		Slottet II			Tången I			Udden II				Solbräcke		. . .
p. 613			p. 614		p. 615			p. 616			p. 616				p. 617		
2	3	4	1	2	1	2	3	1	2	3	1	2	3	4	1	2	. . .
3.3	3.9	4.5	0.5	0.8	14.5	15.2	16	18.4	19.2	20	24.2	25	25.7	26.5	23.5	24	. . .
—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	4 . .
—	3	20	9	6	35	10	14	6	14	10	+	+	4	2	40	42	6 . .
—	—	—	—	12	—	—	—	—	—	—	—	—	—	—	—	—	9 . .
—	—	3	—	—	—	—	—	—	—	5	—	—	—	—	—	—	10 . .
9	21	66	—	—	120	150	135	10	18	10	4	38	52	48	125	95	12 . .
—	2	5	—	—	9	3	—	3	—	—	—	—	4	2	14	11	13 . .
—	—	—	—	—	3	3	2	—	—	—	—	—	—	—	—	—	15 . .
—	+	1	—	—	3	5	+	—	—	—	+	+	—	—	2	—	19 . .
—	2	—	—	—	2	2	4	—	2	—	—	—	20	2	8	6	20 . .
24	40	40	6	3	66	47	38	13	26	30	10	85	58	44	95	80	23 . .
—	2	2	—	—	2	—	—	—	—	7	—	—	—	—	8	—	24 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	25 . .
—	—	—	—	—	+	2	—	—	—	+	—	—	—	—	—	+	26 . .
—	11	2	—	1	14	25	22	2	5	1	—	2	13	12	10	12	29 . .
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	31 . .

693 . .

3

Last uplift

670

	Kårehogen			Fjällbacka I	Udden II	Fiskebäckskil I	Fuglevik					Dal				Fje
	p. 618			p. 618	p. 619	p. 619	p. 620					p. 621				p. 6
. . .	1	2	3		5		1	2	3	4	5	1	2	3	4	1
. . .	×	× + 0.7	× + 1.5	33	27	22	31.5	32.5	33.5	34.5	35	32.5	33	33.5	34	27
. . 2	—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—
. . 6	+	+	—	12	8	11	14	20	23	9	7	23	7	20	7	2
. . 7	—	—	—	—	—	1	—	6	12	1	—	—	—	—	—	—
. . 10	—	—	3	—	—	—	—	1	7	13	20	—	—	—	—	—
. . 11	—	—	—	—	—	3	—	—	—	—	—	—	—	—	3	—
. . 12	—	3	3	21	8	150	170	245	130	45	35	78	122	93	62	24
. . 13	—	—	—	—	1	14	1	—	—	—	1	—	—	—	+	—
. . 15	1	—	—	·	·	—	—	—	—	—	—	—	—	—	—	—
. . 17	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—
. . 19	—	—	—	—	—	—	3	4	2	—	1	1	4	1	3	—
. . 20	1	—	—	15	1	3	9	3	—	—	—	—	2	12	3	—
. . 23	20	30	28	+	58	114	184	180	135	75	77	3	+	8	6	7
. . 24	—	—	—	—	1	1	—	—	6	—	—	—	—	—	—	—
. . 26	—	—	—	—	—	—	—	—	—	—	—	—	+	+	+	—
. . 29	+	1	—	20	4	5	6	14	1	1	1	1	2	—	—	1
. . 31	+	—	—	—	—	—	—	—	—	+	+	—	—	—	—	—

. . . 694

Last uplift
671

3

Fjällbacka III				Fintorp II			Fossa	Hestrand II			Hamn I	Kristineberg I		Hovenäs I	Hovenäs II		
p. 622				p. 623			p. 623	p. 624			p. 624	p. 625		p. 626			
1	2	3	4	1	2	3	2	1	2	3		1	2		1	2	. . .
2	13	14	15	16	16.5	17	10.6	13	14	15	10	9.5	10	14	12.3	13	. . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	5 . .
6	30	33	30	22	10	8	9	12	13	16	6	12	13	27	19	27	6 . .
—	—	—	—	—	+	12	—	—	—	—	—	—	—	—	—	—	10
—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	2	—	11 . .
2	145	95	55	120	40	12	170	30	72	115	7	60	95	16	48	33	12 . .
2	13	3	12	7	+	—	5	9	4	12	—	8	—	—	6	—	13 . .
—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	2	—	15 . .
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	16 . .
+	+	—	—	—	—	—	—	—	1	—	+	—	+	—	—	—	19 . .
—	6	—	10	2	6	—	4	—	8	—	—	—	—	2	8	6	20 . .
—	3	53	55	175	85	30	40	34	55	97	13	18	50	2	18	21	23 . .
—	—	—	—	2	—	—	—	—	—	5	—	—	—	—	—	—	24 . .
—	+	—	—	—	—	—	+	—	1	—	1	—	—	—	—	—	26 . .
4	2	10	11	10	8	4	5	5	17	5	1	14	13	9	7	42	29 . .
—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	32 .

695 . . .

3

Last uplift

672

	Klevekilen I A	Fintorp I			Svenneby V	Slottet I	Hestrand I	Näset II	Svenneby VII			Svenneby I		Svenneby VI	
	p. 627	p. 627			p. 628	p. 628	p. 628	p. 629	p. 629						
. .	3	1	2	3					1	2	3	1	2	1	2
. .	13	7	7.3	8	15	7	12	9	3.8	4.4	5	7	8	6.4	7.2
. 4	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—
. 6	9	19	17	14	44	7	34	66	17	12	35	75	45	9	13
. 7	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
. 10	24	—	—	—	—	—	60	—	—	—	—	—	—	—	—
. 11	—	—	—	—	—	—	—	—	—	3	2	—	2	—	—
. 12	28	56	155	130	120	—	123	122	30	17	6	27	68	60	80
. 13	—	—	3	20	110	—	12	11	3	—	—	32	14	9	10
. 14	—	—	—	2	—	—	—	—	1	5	—	—	—	—	1
. 15	2	—	—	—	—	—	2	—	—	—	—	—	—	—	—
. 19	1	—	+	+	—	—	—	—	+	1	+	2	2	+	2
. 20	—	1	2	4	—	3	6	6	5	—	—	—	6	6	5
. 23	92	5	8	24	225	4	255	20	3	—	—	4	10	7	5
. 24	+	—	—	—	10	—	—	4	—	—	—	—	—	1	—
. 25	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—
. 26	—	—	—	—	—	—	1	—	—	—	—	—	1	—	2
. 29	6	6	10	6	—	—	26	20	9	3	1	6	15	1	4
. 32	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—

696

Last uplift

673

3

Vik I	Varpet		Lökken	Ålestranden	Groten I		Havik				Slependen	Hermanö				
												II	I A	I B	I C	
631	p. 631		p. 632	p. 632	p. 632		p. 633				p. 633	p. 634				
	1	2			1	2	1	2	3	4			4	2		. . .
11	19	20	17	16	18.8	20	×	× + 0.7	× + 1.5	× + 2.2	23	3	3.5	2.5	2.5	. . .
—	5	5	—	—	—	—	—	—	—	—	—	—	—	—	—	4 . .
19	50	62	13	24	13	35	4	2	8	23	20	—	—	+	8	6 . .
—	—	—	4	—	7	2	—	+	—	—	—	—	—	—	—	7 . .
—	—	—	+	—	5	12	10	18	24	16	—	—	—	4	—	10 . .
—	—	—	—	—	—	—	—	—	3	—	—	—	—	1	—	11 . .
13	87	125	58	117	92	190	470	445	450	565	6	210	32	23	24	12 . .
3	—	—	2	3	—	6	11	17	7	—	—	45	—	6	6	13 . .
—	—	—	2	6	—	—	—	—	—	—	—	—	—	—	—	14 . .
—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	1	15 . .
—	2	2	1	2	6	2	4	7	8	4	—	—	—	—	—	19 . .
—	5	20	—	—	4	—	8	12	9	7	—	—	—	—	—	20 . .
7	165	150	+	8	50	135	365	360	410	500	17	110	16	64	24	23 . .
—	2	8	—	—	—	—	—	—	—	—	—	6	—	+	3	24 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	$^1/_2$	—	25 . .
1	+	+	3	—	+	—	—	—	—	—	—	—	—	—	1	26 . .
—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	28 . .
—	42	9	11	—	1	—	2	2	7	22	—	10	—	12	2	29 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	31 . .
—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	32 . .

697 . . .

3

Last uplift

674

	Grundsund		Näset I	Rörvik I	Rörvik II	Vik IV	Florö	Hamn II		Tryggö		Hunnebo	Ålstenshamn I			III
	p. 635		p. 636	p. 636		p. 637	p. 637	p. 638		p. 638		p. 638	p. 639			
. .	1	2	3					1	2	1	2		1	2	3	
. .	1	1.5	4.7	9	5–10	1	5–10	6	7	2	3	1.5	2.8	3.4	4	3
. 6	18	36	9	14	8	9	32	4	22	15	14	14	46	43	35	
. 7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
. 11	—	—	—	—	—	—	—	—	—	2	—	—	—	3	—	—
. 12	40	25	57	23	84	—	20	74	86	93	160	135	225	77	95	3
. 13	12	21	14	3	103	—	—	4	1	5	30	14	64	30	40	2
. 14	—	—	—	—	—	—	+	—	—	—	—	—	—	—	2	—
. 19	—	—	+	—	—	+	—	+	—	+	—	1	—	—	—	—
. 20	—	—	—	—	4	—	—	—	—	6	5	3	—	—	—	—
. 23	+	20	23	3	113	1	3	84	130	16	12	35	135	45	2	3
. 24	—	—	3	—	70	—	+	1	1	—	10	1	1	—	6	3
. 26	+	—	—	+	1	—	1	1	—	1	1	1	—	—	—	—
. 29	8	4	7	10	4	—	—	9	16	22	15	7	—	1	12	
. 32	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—

698

Last uplift

675

3

dbrug II		Groten II		Ödegården		Lavösund I	Hovenäs III	Svenneby II	Vik II		Vikekilen I		Svenneby IV	Ålstenshamn II	
. 640		p. 641		p. 641		p. 642	p. 642	p. 642	p. 643		p. 643		p. 644	p. 644	
		1	2	1	2		3		1	2	1	2		1	. . . .
15	14	7	8	×	× + 0.8	1.3	1.2	3	0.5	1	0.6	1.3	1.5	–0.2	. . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	15	4 . . .
1	37	3	2	9	5	2	2	14	20	33	16	40	6	30	6 . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	6	—	7 . . .
—	—	—	—	7	6	—	—	—	—	—	—	—	4	—	10 .
—	+	—	—	—	—	—	—	1	—	—	—	—	—	—	11 . .
2	83	18	80	9	140	4	—	60	48	16	28	16	26	140	12 . .
—	26	—	—	4	3	—	—	6	—	1	—	4	9	7	13 . .
—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	14 . .
—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	16 . .
—	8	1	1	—	—	—	—	—	+	3	3	—	—	—	19 . .
—	—	—	—	—	—	2	—	—	2	—	—	—	—	—	20 . .
1	1	9	35	24	157	8	7	50	4	4	+	2	30	85	23 . .
—	—	—	—	—	—	—	1	1	—	—	—	—	1	7	24 . .
—	—	+	+	+	—	—	—	—	+	—	1	—	—	8	26 . .
—	11	1	3	—	8	—	—	2	10	5	6	18	—	20	29 . .
—	—	—	—	2	2	—	—	—	—	—	—	—	—	—	31

699 . . .

3

Modern
676

	Smalsundet			Kristineberg II					Fiskebäcks-kil II	Hermanö III	Ålstens-hamn II	Vik III	Vike-kilen	
	A	B	C	A	B	C	D	E					II	II
. .	p. 499			p. 501					p. 503	p. 504	p. 505	p. 505	p. 506	
. .	–1	–0.5	0	0.75	0.6	0.3	0.1	0	–0.2	0	0.4	0	0	0
. 6	12	+	18	12	35	32	+	2	—	31	30	10	14	3
. 9	—	—	—	—	—	—	—	4	—	—	—	—	—	
. 10	13	7	280	—	3	15	48	11	115	5	37	—	—	2
. 11	—	—	—	—	—	—	—	1	—	—	—	—	—	—
. 12	20	1	33	40	68	25	17	3	1	100	15	15	—	—
. 13	2	—	1	3	—	1	2	1	—	11	1	—	—	—
. 17	—	—	—	—	—	2	—	1	—	—	—	—	—	—
. 19	—	—	1	1	1	—	—	—	—	—	—	—	—	—
. 20	—	—	—	—	2	—	—	—		—	—	—	—	
. 23	47	15	260	27	90	65	90	57	48	135	220	60	105	
. 24	—	—	3	—	2	—	3	—	—	4	1	—	2	
. 25	—		—	—	+	—	—	—	—	—	—	—	—	
. 26	1	—	—	1	2	—	1	+	—	—	—	—	—	
. 29	2	—	—	—	3	3	7	4	—	22	15	—	4	
. 31	—	+	6	—	—	—	2	1	1	—	—	—	—	

. . . 700

Modern

677

3 Continued from page

venne- y III A	B	Skar-vik	Ström-sund	Bär-vi-ken	Lind-holmen I	II	Hum-le-säcken	Flat-holmen I	II	Gåsöredd I	II	III	IV	Gull-maren				
p. 506		p. 507	p. 509	p. 510	p. 510		p. 511	p. 513		p. 514				p. 517		Number of samples		
0	0	0	-5	-15	-15	-20	-30	-30	-30	-30	-35	-30	-30	-70		Height ›		
																1 *Eulima bilineata*	bl	d
																2 › *distorta*	$b^{m}l$	d
—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	3	3 › *polita*	$b^{l}l$	d
—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	4	4 *Eulimella acicula*	$b^{l}l$	d
																5 › *ventricosa*	$b^{m}l$	d
18	2	3	30	4	1	4	5	4	13	+	—	1	3	7	6	6 *Gibbula cineraria*	bl	sd
																7 › *tumida*	$a^{l}bl$	d
																8 *Hinnites pusio*	$b^{l}l$	d
																9 *Hydrobia minuta*	b	s
43	68	—	—	—	—	—	—	—	4	—	—	—	—	—	10	10 › *ulvae*	$a^{l}bl$	s
																11 *Kellia suborbicularis*	bl	d
20	12	15	2	—	—	—	5	—	6	—	1	—	—	—	12	12 *Lacuna divaricata*	$a^{l}bl$	s
4	4	1	—	—	—	—	—	—	—	—	—	—	—	—	13	13 › *pallidula*	$a^{l}bl$	s
																14 › *puteolus*	$b^{l}l$	s
																15 *Lasaea rubra*	$b^{l}l$	sd
—	—	—	—	—	1	—	+	3	3	—	1	1	2	2	16	16 *Leda minuta*	ab	d
																17 *Lepeta caeca*	ab	d
—	—	—	—	—	—	—	1	4	1	—	—	—	—	6	18	18 › *fulva*	$a^{l}bl$	d
—	—	—	—	—	2	5	2	1	4	—	4	4	+	4	19	19 *Lepidopleurus asellus*	bl	d
—	—	—	—	—	—	1	—	—	2	—	—	—	—	—	20	20 *Lepton nitidum*	$b^{l}l$	d
—	—	—	—	—	3	2	—	6	5	—	—	1	—	—	21	21 *Lima loscombi*	$b^{m}l$	d
—	—	—	—	—	—	—	2	—	—	—	—	—	+	3	22	22 › sp.		
10	125	47	7	11	3	+	3	4	+	—	1	3	+	4	23	23 *Littorina littorea-rudis*	$a^{l}bl$	s
—	3	1	1	—	—	—	—	—	—	—	—	—	—	—	24	24 › *obtusata*	$a^{l}bl$	s
																25 *Lophyrus albus*	ab	d
—	1	—	—	—	—	—	2	2	1	3	+	1	+	2	26	26 *Lucina borealis*	bl	d
—	—	—	—	—	—	—	2	2	2	—	2	4	3	5	27	27 › *spinifera*	$b^{l}l$	d
																28 *Lucinopsis undata*	bl	d
5	1	8	—	—	—	4	3	14	1	—	2	—	2	—	29	29 *Lunatia intermedia*	$b^{m}l$	sd
—	—	—	—	—	—	—	—	—	+	—	—	—	—	—	30	30 *Lyonsia norvegica*	$b^{m}l$	d
1	1	—	—	—	—	—	—	—	—	—	—	+	—	—	31	31 *Macoma baltica*	$a^{l}bl$	s
—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	32	32 › *calcaria*	abm	d

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Continued on page

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Continued from page 678

					Ancylus sinking						Ancylus uplitt								
					Gude-bo	Skårbo			Knuts-dalen		Bred-hult		Skär-je-dalen	Ox-torp	Ullerö	Tose			Häst käll
					p. 598	p. 599			p. 600		p. 600		p. 601	p. 602	p. 603	p. 604			p. 60
Number of samples						1	2	3	1	2	1	2				1	2	3	
Height »					46.3	44.2	45.2	46	53	54	70	71	63	49	59	55.8	56.4	57	33.5
bl	s	1	*Macoma tenuis*																
		2	» sp.																
$\mathrm{a^{l}b}$	d	3	*Mactra elliptica*																
bl	sd	4	» *subtruncata*																
		5	» sp.																
$\mathrm{b^{l}l}$	sd	6	*Mangelia costata*																
ab	d	7	*Margarita groenlandica*																
ab	d	8	» *helicina*																
a	sd	9	*Modiolaria corrugata*																
bl	sd	10	» *discors*																
		11	» sp.																
ab	d	12	*Moelleria costulata*																
bl	d	13	*Montacuta bidentata*	13	—	—	—	—	—	—	—	3	3	—	—	16	8	3	—
bl	d	14	» *substriata*																
$\mathrm{a^{l}b}$	s	15	*Mya arenaria*																
w	sd	16	» *truncata*	16	+	—	+	—	¹/₂	¹/₂	—	1	¹/₂	1	—	+	—	—	
$\mathrm{a^{l}bl}$	s	17	*Mytilus edulis*	17	+	245	220	145	80	13	485	830	72	18	6	300	225	65	
$\mathrm{a^{l}b}$	sd	18	» *modiolus*																
$\mathrm{a^{l}bl}$	sd	19	*Nacella pellucida*																
bl	sd	20	*Nassa incrassata*																
$\mathrm{b^{l}l}$	sd	21	» *reticulata*	21	1	—	—	—	—	—	—	—	—	—	+	1	—	7	—
		22	» sp.	22	1	2	—	—	—	—	+	—	—	—	—	4	—	—	—
abm	d	23	*Neptunea despecta*																
$\mathrm{b^{m}l}$	d	24	*Nucula nucleus*	24	—	+	—	—	—	—	—	—	2	—	—	—	—	—	—
$\mathrm{b^{l}l}$	d	25	» *sulcata*																
w	d	26	» *tenuis*																
		27	» sp.																
$\mathrm{b^{l}l}$	sd	28	*Odostomia albella-rissoides*	28	—		—	—	—	—	—	—	—	—	—	360	40	—	—
$\mathrm{b^{l}l}$	d	29	» *conoidea*																
bl	sd	30	» *turrita*																
$\mathrm{a^{l}bl}$	sd	31	» *unidentata*	31	—	—	—	—	—	—	4	—	—	—	—	—	—	—	—
		32	» sp.																

Continued on page 702

Ancylus uplift
679

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. . .

	Udden I				Lavö			Fyka					Lersten					
	p. 605				p. 605			p. 606					p. 607					
1	2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	4	5	. . .
3	34	35	35.5	36	18	19	20	20.2	21	21.7	22.5	23	15	16	17	18	19	. . .
—	—	—	—	—	—	—	12	—	—	—	—	—	—	—	—	—	—	1 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	4	4	—	—	—	8 . . .
—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	10 . .
—	—	—	2	2	—	—	3	—	—	3	—	—	—	—	6	—	—	13 . .
2	–	—	—	—	3	3	3	—	4	+	4	6	3	$^{1}/_{2}$	3	—	—	16 . .
25	425	125	95	150	200	220	145	16	260	325	410	210	57 +	230	465	155	220	17 . .
+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	19 . .
2	—	—	—	1	2	—	+	—	—	—	—	—	—	—	—	—	—	20 . .
—	—	—	+	1	—	—	+	—	1	—	—	—	—	—	—	—	—	21 . .
—	—	—	—	—	—	—	6	—	+	—	—	—	—	—	—	—	—	22 . .
–	—	3	—	3	–	—	—	—	—	—	—	—	—	—	—	—	—	30 . .
—	—	–	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	32 . .

4

Ancylus uplift

680

	Klevekilen							Fossa	Röd			Fjällbacka II			Sörgården	Tången II	Näsett	
	II	I																
		A		B														
	p. 608	p. 608						p. 610	p. 610			p. 611			p. 612	p. 612	p. 61	
. .		1	2	1	2	3	4	1	1	2	3	1	2	3		3	1	
. .	17	12	12.6	11.2	12	12.5	13	10	9	10	10.6	8.5	9.2	10	2	2	4	4
. 1	—	—	—	—	—	—	—	—	50	—	1	—	—	—	—	5	—	
. 3	—	—	—	—	—	—	—	—	415	—	—	—	—	—	—	—	—	
. 4	—	—	—	—	—	—	—	—	25	—	—	—	—	$^1/_2$	—	5	—	
. 8	2	—	—	—	—	—	—	—	—	2	4	—	—	—	—	—	—	
. 10	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	
. 11	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	
. 12	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	
. 13	—	5	3	—	2	1	—	2	7	2	7	—	—	—	—	3	9	
. 16	—	—	1	1	2	—	1	—	2	$^1/_2$	5	—	$^1/_2$	—	3	+	—	
. 17	125	505	255	37	300	210	200	32	115	170	300	13 +	33	185	+	8	210	1
. 18	1	—	—	—	—	—	—	—	+	$^1/_2$	—	—	—	—	—	3	4	
. 20	1	—	—	—	—	—	—	8	3	—	—	—	—	—	—	—	+	
. 21	—	—	—	—	—	—	—	+	—	—	—	—	—	1	—	3	+	
. 22	—	1	1	—	—	+	+	16	45	—	—	—	—	—	—	—	3	
. 23	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	
. 24	2	—	—	—	—	—	1	—	+	$^1/_2$	—	—	—	—	—	—	—	
. 26	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
. 27	—	—	—	—	—	—	—	—	—	—	+	—	—	—	+	—	—	
. 28	—	—	—	—	—	—	—	8	—	—	—	—	—	—	—	6	30	
. 30	—	—	—	—	—	—	—	4	—	6	—	—	—	—	—	—	3	
. 31	—	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	

. . .

704

Tapes sinking

681

4

	Ellene			Hovenäs III		Slottet II			Tången I			Udden II				Solbräcke		
	p. 613			p. 614		p. 615			p. 616			p. 616				p. 617		
	2	3	4	1	2	1	2	3	1	2	3	1	2	3	4	1	2	. . .
.3	3.3	3.9	4.5	0.5	0.8	14.5	15.2	16	18.4	19.2	20	24.2	25	25.7	26.5	23.5	24	. . .
—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	1 . .
—	—	—	—	—	—	2	—	5	—	—	—	—	—	—	—	—	—	4 . .
—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	2	+	5 . .
—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6 . .
—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4	11 . .
—	—	3	3	—	19	3	5	7	2	8	—	—	—	2	1	15	20	13 . .
—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	—	14 . .
—	—	2	—	2	1	4	5	5	1	1	—	—	—	2	—	2	4	16 . .
0	80	43	22	2	+	135 +	110	90	48	48	20	37 +	140	115	115	270	260	17 . .
—	—	—	—	—	—	—	1	—	25	1	—	+	—	—	—	5	8	18 .
—	—	2	—	—	—	—	—	+	—	+	—	—	+	—	—	2	1	20 . .
—	—	—	+	1	1	—	2	+	—	—	—	—	—	+	+	+	4	21 . .
—	—	6	7	—	—	2	14	60	—	—	—	—	8	8	+	3	8	22 . .
—	—	2	—	—	—	—	—	—	—	—	—	—	—	1	—	+	+	24 . .
—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	27 . .
—	—	—	—	—	—	9	9	—	—	—	—	—	—	—	16	30	28	28 . .

705 . . .

4

Last uplift

682

	Kårehogen			Fjällbacka I	Udden II	Fiskebäckskil I	Fuglevik					Dal				Fjel	
	p. 618			p. 618	p. 619	p. 619	p. 620					p. 621				p. 62	
. .	1	2	3		5		1	2	3	4	5	1	2	3	4	1	
. .	×	× + 0.7	× + 1.5	33	27	22	31.5	32.5	33.5	34.5	35	32.5	33	33.5	34	27	2
. 2	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	
. 3	—	—	—	—	—	—	—	—	—	—	—	—	—	+	2	—	
. 4	2	—	—	+	—	—	1	3	3	3	—	—	—	—	—	—	
. 6	+	— —		—	—	—	—	—	—	—	—	—	—	1	—	—	
. 10	—	—	—	—	—	—	—	—	—	—	—	—	+	4	—	—	
. 13	5	3	—	8	1	—	15	9	3	—	3	5	8	8	6	—	
. 16	2	2	1	3	—	—	+	—	—	+	—	—	—	—	—	—	
. 17	9	18	4	2	45	27	390	540	355	335	244	245	400	350	205	45	4
. 18	—	—	—	+	—	—	—	+	—	+	—	—	—	—	—	—	
. 20	—	—	—	—	1	1	1	+	1	—	3	1	+	—	—	—	
. 21	+	—	2	2	2	1	+	+	1	—	3	—	—	—	+	1	
. 22	—	—	—	21	+	15	25	55	12	6	—	3	—	8	—	—	
. 24	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
. 25	—	—	—	—	—	—	—	—	—	—	—	+	—	+	—	—	
. 27	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—	
. 28	—	—	—	12	4	20	24	30	50	6	5	33	12	8	3	2	
. 30	—	—	—	3	—	10	—	—	—	—	—	—	—	—	—	2	

. .

706

Last uplift

683

4 . . .

Fjällbacka III			Fintorp II			Fossa	Hestrand II			Hamn I	Kristineberg I		Hovenäs I	Hovenäs II		
p. 622			p. 623			p. 623	p. 624			p 624	p. 625		p. 626			
2	3	4	1	2	3	2	1	2	3		1	2		1	2	. . .
13	14	15	16	16.5	17	10.6	13	14	15	10	9.5	10	14	12.3	13	. . .
	—	—	4	—	—	—	—	—	7	—	—	—	—	—	—	1 . .
—	—	—	—	—	—	—	—	—	11	—	—	—	—	—	—	3 . .
—	—	—	5	3	—	—	—	—	—	—	—	—	—	—	+	4 . .
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	7 . .
25	27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	9 . .
—	—	—	—	—	—	4	9	3	—	—	—	2	—	—	—	10 . .
—	—	—	—	—	—	—	—	—	5	—	—	—	—	—	—	12 . .
10	14	20	2	2	2	6	8	10	1	1	—	—	6	2	5	13 . .
—	—	—	—	2	—	4	4	—	1	1	—	—	4	—	—	16 . .
190	225	110	46	120	70	9	180	130	105	7	145	250	1	8	6	17 . .
5	10	—	3	2	—	2	3	5	4	1	1	+	1	3	—	18 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	19 . .
2	2	—	—	1	—	6	—	+	—	1	—	1	—	—	—	20 . .
2	2	12	2	6	1	2	—	—	6	2	2	—	—	—	—	21 . .
—	—	—	4	4	4	24	—	8	—	—	4	12	3	2	6	22 . .
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	23 .
2	—	—	—	—	—	—	—	—	—	1	—	—	—	—	+	24 . .
—	—	—	+	+	—	—	—	—	—	—	—	—	—	—	—	27 . .
100	110	85	32	8	8	20	40	64	15	—	32	20	6	—	—	28 . .
—	—	5	—	—	—	4	—	—	—	—	—	—	3	—	—	30 . .
—	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	31 . .

707 . . . .

4

Last uplift

684

	Klevekilen I A	Fintorp I			Svenneby V	Slottet I	Hestrand I	Näset II	Svenneby						
									VII			I		VI	
	p. 627	p. 627			p. 628	p. 628	p. 628	p. 629	p. 629						
. .	3	1	2	3					1	2	3	1	2	1	2
. . .	13	7	7.3	8	15	7	12	9	3.8	4.4	5	7	8	6.4	7.2
. . 2	1	—	—	—	—	—	—	—		—	—	—	—	—	—
. . 3	—	—	—	—	—	—	5	—	—	—	—	—	—	—	—
. . 6	—	—	—	—	—	+	—	—	—	3	—	—	—	—	—
. 10	—	8	9	14	—	—	—	—	—	—	—	3	2	—	—
. 13	—	—	3	2	4	6	8	28	12	—	6	13	18	20	14
. 16	2	—	—	—	—	+	—	—	—	—	—	1	—	—	—
. 17	210	35	100	155	200	+	125	9	+	+	1	75	52	22	19
. 18	—	—	1	—	1	—	—	+	—	—	—	1	1	—	2
. 20	—	—	—	—	—	2	—	—	1	1	+	—	—	1	2
. 21	—	—	1	2	11	2	+	1	11	20	7	—	—	4	6
. 22	5	3	3	—	—	6	10	4	—	—	—	+	1	8	3
. 24	—	—	—	—	—	—	—	—	—	+	—	—	—	2	—
. 27	—	+	+	—	+	—	—	—	—	—	—	—	—	—	+
. 28	—	8	45	40	8	9	56	8	—	3	7	3	12	—	—
. 30	—	—	3	—	8	—	—	4	—	—	—	6	—	—	—
. 31		—	—	—	—	—	—	—	—		—	—	—	—	3

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708

Last uplift

685

4

k	Varpet		Lökken	Ålestranden	Groten I		Havik				Slependen	Hermanö II	Hermanö I A	B	C	
31	p. 631		p. 632	p. 632	p. 632		p. 633				p. 633	p. 634				
	1	2			1	2	1	2	3	4			4	2		. . . .
	19	20	17	16	18.8	20	×	× + 0.7	× + 1.5	+ × 2.2	23	3	3.5	2.5	2.5	. . . .
-	—	—	—	—	—	—	—	—	—	—	—	—	—	26	8	1 . . .
-	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	2 . . .
-	—	—	—	—	—	—	—	—	—	—	—	—	—	23	10	3 . . .
-	—	3	4	—	—	4	—	—	—	—	—	1	—	—	—	4 . . .
-	—	—	—	3	1	—	—	—	—	—	—	—	—	—	—	6 . . .
-	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	8 . . .
-	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	10 . . .
-	—	15	3	2	2	—	3	6	24	18	2	24	5	8	8	13 . . .
-	4	—	+	—	—	—	8	+	+	+	—	—	—	1	1	16 . . .
1	320	215	5	13	230	410	560	535	500	515	—	15	600	75	55	17 . . .
-	—	—	+	—	—	—	+	—	—	—	—	—	—	—	—	18 . . .
-	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	19 . . .
-	1	1	2	1	2	14	—	3	1	8	—	1	—	—	1	20 . . .
7	2	4	2	1	2	2	2	3	13	1	3	20	—	3	1	21 . . .
-	20	25	—	—	8	—	5	18	42	14	—	36	—	5	—	22 . . .
-	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	24 . . .
.	—	—	—	—	+	+	—	—	—	—	—	+	—	—	—	27 . . .
.	30	10	—	—	—	12	105	210	180	170	2	—	5	—	—	28 . . .
.	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	29 . . .
.	—	5	—	—	8	—	—	—	—	—	—	3	—	—	6	30 . . .

709

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4

Last uplift

686

	Grund-sund		Näset I	Rörvik I	Rörvik II	Vik IV	Florö	Hamn II		Tryggö		Hun-nebo	Ålstensham I		
	p. 635		p. 636	p. 636		p. 637	p. 637	p. 638		p. 638		p. 638	p. 639		
. . . .	1	2	3					1	2	1	2		1	2	3
. . . .	1	1.5	4.7	9	5–10	1	5–10	6	7	2	3	1.5	2.8	3.4	4
. . 3	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
. . 4	+	—	—	2	—	—	—	—	—	2	—	4	—	—	—
. . 6	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
. . 9	—	—	—	—	—	—	—	—	—	2	2	—	—	11	2
. . 13	8	16	3	4	9	—	5	—	3	15	18	30	9	8	—
. . 16	1	1	—	+	2	—	+	—	—	3	2	—	—	—	—
. . 17	+	1	38	8	13	—	9	14	14	65	25	1	140	265	45
. . 18	—	—	—	+	2	—	—	—	—	3	—	—	2	5	1
. . 20	2	—	6	+	—	—	+	—	1	—	—	—	—	—	1
. . 21	+	—	—	5	4	3	+	1	5	2	—	10	3	—	—
. . 22	5	11	—	—	—	—	10	4	—	11	8	—	12	—	15
. . 24	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—
. . 27	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. . 28	4	8	—	—	—	—	5	—	5	3	6	—	24	50	20
. . 30	—	—	—	3	—	—	—	4	—	—	—	—	24	—	—
. . 31	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—

. . . 710

Last uplift
687

4

. . . .

dbrug II		Groten II		Ödegården		Lavösund I	Hovenäs III	Svenneby II	Vik II		Vikekilen I		Svenneby IV	Ålstenshamn II	
. 640		p. 641		p. 641		p. 642	p. 642	p. 642	p. 643		p. 643		p. 644	p. 644	
		1	2	1	2		3		1	2	1	2		1	. . . .
15	14	7	8	×	× + 0.8	1.3	1.2	3	0.5	1	0.6	1.3	1.5	–0.2	. . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	5	—	1 . . .
—	—	—	—	—	—	—	—	—	—	+	—	—	—	—	2 . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	20	—	3 . . .
—	—	—	—	—	—	—	—	—	—	—	—	1	—	7	4 . . .
—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	5 . . .
—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	6 . . .
2	3	4	6	—	+	7	1	30	14	2	2	4	—	20	13 . . .
—	3	—	—	+	—	—	—	1	5	—	—	1	—	—	16 . . .
3	55	200	115	40	95	+	+	38	+	2	40	14	20	125	17 . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	3	—	18 . . .
—	5	1	3	—	1	—	—	—	5	1	—	2	—	2	20 . . .
3	1	+	4	+	3	+	—	—	4	1	—	+	—	2	21 . . .
2	3	—	—	15	15	—	—	—	8	8	7	4	+	5	22 . . .
—	+	—	—	—	—	—	—	—	—	—	—	—	—	—	24 . . .
—	—	—	+	—	—	—	—	—	+	—	—	—	—	—	27 . . .
2	3	—	6	—	—	—	—	30	12	—	—	—	—	35	28 . . .
—	—	—	—	—	—	—	—	—	4	4	—	—	—	—	31 . . .

711

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4

Modern

688

	Smalsundet A	Smalsundet B	Smalsundet C	Kristineberg II A	Kristineberg II B	Kristineberg II C	Kristineberg II D	Kristineberg II E	Fiske-bäcks-kil II	Her-manö III	Ålstens-hamn II	Vik III	Vike-kilen II
. . . .	p. 499			p. 501					p. 503	p. 504	p. 505	p. 505	p. 50
. . . .	-1	-0.5	0	0.75	0.6	0.3	0.1	0	-0.2	0	0.4	0	0
. . 1	—	—	2	10	2	—	1	1	+	1	—	—	—
. . 3	—	—	—	—	—	—	—	—	—	5	—	—	—
. . 4	—	—	4	1	4	12	11	4	4	—	—	—	2
. . 8	—	—	—	—	—	6	—	—	—	—	—	—	—
. 10	—	—	1	—	—	—	—	—	—	—	—	—	—
. 13	1	+	—	3	—	—	—	—	—	—	—	—	2
. 15	—	—	—	—	—	1	9	—	2	—	—	—	—
. 16	2	—	18	7	4	15	10	3	3	15	—	3	—
. 17	10	+	48	10	7	77	28	18	2	14	11	2	13
. 18	—	+	3	—	—	1	—	—	—	—	—	—	—
. 20	6	—	6	—	—	3	11	2	—	2	—	—	—
. 21	—	—	2	—	2	—	7	—	1	2	—	—	—
. 22	—	—	—	15	25	—	—	—	—	36	4	5	5
. 24	—	—	—	—	—	—	—	—	—	1	—	—	—
. 28	—	—	6	—	3	5	—	—	—	—	—	—	—

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712

Modern

689

. . . . Continued from page

4

venne-y III		Skarvik	Strömsund	Bärviken	Lindholmen		Humlesäcken	Flatholmen		Gåsöredd				Gullmaren				
	B				I	II		I	II	I	II	III	IV					
p. 506		p. 507	p. 509	p. 510	p. 510		p. 511	p. 513		p. 514				p. 517		. . . . Number of samples		
	0	0	-5	-15	-15	-20	-30	-30	-30	-30	-35	-30	-30	-70		. . . . Height ›		
—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	1	. . . . 1 *Macoma tenuis*	bl	s
																. . . . 2 › sp.		
—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	3	. . . . 3 *Mactra elliptica*	$a^{l}b$	d
1	—	—	—	1	—	—	—	—	—	—	—	1	—	—	4	. . . . 4 › *subtruncata*	bl	sd
																. . . . 5 › sp		
—	—	—	—	—	1	—	—	2	1	—	—	2	—	—	6	. . . . 6 *Mangelia costata*	$b^{l}l$	sd
																. . . . 7 *Margarita groenlandica*	ab	d
																. . . . 8 › *helicina*	ab	d
																. . . . 9 *Modiolaria corrugata*	a	sd
																. . . . 10 › *discors*	bl	sd
																. . . . 11 › sp.		
																. . . . 12 *Moelleria costulata*	ab	d
—	—	—	—	—	—	—	1	2	—	—	1	—	1	1	13	. . . . 13 *Montacuta bidentata*	bl	d
																. . . . 14 › *substriata*	bl	d
—	2	—	2	—	—	—	—	—	—	—	—	—	—	—	15	. . . . 15 *Mya arenaria*	$a^{l}b$	s
1	3	—	3	—	3	2	1	—	—	—	1	—	+	1	16	. . . . 16 › *truncata*	w	sd
[illegible]	9	5	4	9	—	—	4	+	1	—	—	—	+	15	17	. . . . 17 *Mytilus edulis*	$a^{l}bl$	s
—	—	—	2	—	2	+	1	1	2	+	1	+	+	+	18	. . . . 18 › *modiolus*	$a^{l}b$	sd
—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	19	. . . . 19 *Nacella pellucida*	$a^{l}bl$	sd
—	—	—	—	—	7	12	18	60	100	—	2	10	2	14	20	. . . . 20 *Nassa incrassata*	bl	sd
—	—	—	—	5	+	—	—	—	—	—	+	—	+	4	21	. . . . 21 › *reticulata*	$b^{l}l$	sd
—	2	+	—	—	—	—	—	—	—	—	—	—	—	—	22	. . . . 22 › sp.		
																. . . . 23 *Neptunea despecta*	ab^{m}	d
—	—	—	—	—	2	+	2	3	5	+	5	5	3	4	24	. . . . 24 *Nucula nucleus*	$b^{m}l$	d
—	—	—	—	—	—	—	—	—	+	—	—	—	—	—	25	. . . . 25 › *sulcata*	$b^{l}l$	d
—	—	—	—	2	—	—	3	2	3	—	—	2	—	—	26	. . . . 26 › *tenuis*	w	d
																. . . . 27 › sp.		
[illegible]	—	—	—	—	—	2	1	4	9	—	—	1	—	—	28	. . . . 28 *Odostomia albella-rissoides* . . .	$b^{l}l$	sd
—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	29	. . . . 29 › *conoidea*	$b^{l}l$	d
																. . . . 30 › *turrita*	bl	sd
—	—	—	—	—	—	—	1	2	—	—	—	—	—	—	31	. . . . 31 › *unidentata*	$a^{l}bl$	sd
																. . . . 32 › sp.		

. . . . Continued on page

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Continued from page 690

					Ancylus sinking						Ancylus uplift								
					Gudebo	Skårbo			Knutsdalen		Bredhult		Skärjedalen	Oxtorp	Ullerö	Tose			Häst käll
					p. 598	p. 599			p. 600		p. 600		p. 601	p. 602	p. 603	p. 604			p. 60
Number of samples						1	2	3	1	2	1	2				1	2	3	
Height »					46.3	44.2	45.2	46	53	54	70	71	63	49	59	55.8	56.4	57	33.
a^{l}bl	s	1	*Onoba aculeus-striata*	1	—	42	5	8	6	—	100	15	125	—	—	156	60	—	—
b^{l}l	d	2	» *vitrea*																
b^{l}l	sd	3	*Ostrea edulis*	3	—	—	—	—	—	—	—	—	—	—	+	—	+	3	—
b^{m}l	d	4	*Parthenia interstincta*	4	—	—	—	—	—	—	—	5	—	—	—	—	—	—	—
bl	d	5	» *spiralis*	5	—	2	—	—	—	—	4	—	—	—	—	8	5	—	—
b	s	6	*Patella vulgata*	6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2
ab^{h}	d	7	*Pecten islandicus*	7	—	+	—	—	—	+	+	—	+	—	—	—	—	—	—
b^{m}l	d	8	» *opercularis*																
bl	d	9	» *septemradiatus*																
bl	d	10	» *tigrinus*																
b^{l}l	sd	11	» *varius*																
a^{l}bl	d	12	*Philine quadrata*																
a^{h}	sd	13	*Portlandia arctica*																
w	d	14	» *lenticula*																
b^{m}l	d	15	» *tenuis*																
		16	» sp.																
bl	d	17	*Psammobia ferroeensis*																
l	s	18	» *vespertina*																
ab	d	19	*Puncturella noachina*																
a^{l}b	s	20	*Purpura lapillus*	20	—	—	—	—	—	—	—	—	—	+	—	2	—	—	1
b^{l}l	s	21	*Rissoa albella*																
bl	sd	22	» *inconspicua*	22	—	—	—	—	—	—	—	—	—	—	—	4	5	—	—
a^{l}bl	sd	23	» *interrupta*	23	—	16	—	—	3	—	96	10	45	—	—	1 200	225	—	—
b^{m}l	s	24	» *membranacea*	24	—	—	—	—	—	—	—	—	6	—	—	—	—	—	—
b^{l}l	sd	25	» *parva*	25	—	—	—	—	—	—	—	—	—	—	6	24	10	—	—
b^{m}l	sd	26	» *violacea*																
(w)a	sd	27	*Saxicava arctica*	27	1	6	4	8	7	13	21	6	15	3	—	54	8	1	—
b^{l}l	d	28	*Scalaria communis*																
b^{l}l	s	29	*Scrobicularia piperata*																
w	s	30	*Skenea planorbis*	30	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—
bl	sd	31	*Solen ensis*	31	—	—	—	—	—	—	—	—	—	+	—	—	—	—	+
bl	s	32	*Spirialis retroversus*																

Continued on page 714

Ancylus uplift
691

5

Udden I p. 605				Lavö p. 605			Fyka p. 606					Lersten p. 607					
2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	4	5	. . . .
34	35	35.5	36	18	19	20	20.2	21	21.7	22.5	23	15	16	17	18	19	. . . .
6	6	21	24	95	—	24	—	25	10	25	15	54	44	27	—	—	1 . . .
—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	3 . . .
—	—	—	3	—	—	6	—	—	5	—	—	—	—	—	—	—	5 . . .
—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	6 . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	10 . . .
—	—	—	—	—	—	—	—	—	—	—	—	½	—	—	—	—	19 . . .
—	—	—	—	—	+	18	—	—	—	—	—	—	—	—	—	—	20 . . .
—	—	3	12	—	—	—	—	—	—	—	—	—	—	—	—	—	22 . . .
6	6	36	105	100	—	370	5	30	—	20	20	34	24	24	—	—	23 . . .
—	2	—	4	—	—	2	—	—	—	—	—	—	—	—	—	—	24 . . .
115	147	430	1 080	—	—	36	—	—	—	—	5	—	—	6	—	—	25 . . .
—	—	—	9	—	—	—		—	—	—	—	—	—	—	—	—	26 . . .
8	3	7	28	10	14	20	—	24	5	2	6	4	½	7	+	—	27 . . .

715 . . . .

5

Ancylus uplift

692

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	Klevekilen II p. 608	Klevekilen I A p. 608		Klevekilen I B				Fossa p. 610	Röd p. 610			Fjällbacka II p. 611			Sörgården p. 612	Tången II p. 612	Näse p. 6	
. . . .		1	2	1	2	3	4	1	1	2	3	1	2	3		3	1	
. . . .	17	12	12.6	11.2	12	12.5	13	10	9	10	10.6	8.5	9.2	10	2	2	4	
. . 1	28	18	18	—	5	28	32	120	765	12	20	—	2	12	—	33	80	
. . 3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	
. . 4	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	
. . 5	—	—	—	—	—	4	4	28	—	—	—	—	—	—	—	3	—	
. . 6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	
. . 7	—	—	—	—	—	—	—	—	+	$^1/_2$	—	—	—	—	—	—	—	
. . 10	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	
. . 11	—	+	—	—	—	—	—	2	+	—	—	—	—	—	—	—	—	
. . 13	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	
. . 20	1	+	+	—	+	—	—	3	5	—	—	—	—	+	+	9	5	
. . 22	2	—	—	—	—	—	4	32	—	—	—	—	—	—	—	—	27	
. . 23	6	30	6	—	—	40	32	680	2 025	8	4	—	—	40	—	210	450	
. . 24	—	—	1	—	—	—	—	14	45	—	—	$^1/_2$	—	2	—	—	11	
. . 25	4	50	30	—	4	36	20	820	2 625	—	—	3	7	380	—	12	880	3
. . 26	1	—	—	—	—	—	—	36	255	—	—	—	—	8	—	—	8	
. . 27	15	10	7	—	5	4	6	82	28	20	37	—	—	3	6	23	40	
. . 30	2	—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	

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716

Tápes sinking

693

5

Ellene				Hovenäs III		Slottet II			Tången I			Udden II				Solbräcke		
p. 613				p. 614		p. 615			p. 616			p. 616				p. 617		
1	2	3	4	1	2	1	2	3	1	2	3	1	2	3	4	1	2	. .
2.3	3.3	3.9	4.5	0.5	0.8	14.5	15.2	16	18.4	19.2	20	24.2	25	25.7	26.5	23.5	24	. .
—	6	18	90	4	—	40	42	44	3	3	10	2	20	60	40	160	110	1 .
—	—	—	+	2	+	—	—	—	+	—	—	—	—	2	—	2	+	3 .
—	—	3	12	—	—	—	—	4	—	—	10	—	—	—	—	—	8	5 .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	6 .
—	—	—	1	+	+	—	+	3	—	—	—	—	—	—	—	—	—	11 .
—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	15 .
—	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	16 .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	18 .
—	—	—	—	—	—	2	—	—	1	—	—	—	—	—	—	—	—	19 .
—	—	—	2	—	—	3	10	+	—	3	—	1	4	—	—	11	13	20 .
—	—	—	9	—	—	60	235	170	—	—	—	—	—	16	4	33	80	22 .
—	12	40	156	—	—	720	600	600	30	60	40	6	40	100	80	975	840	23 .
—	—	—	7	—	1	2	15	34	—	—	—	—	—	—	1	42	48	24 .
—	27	120	625	—	—	180	675	1 260	3	—	5	2	20	500	150	100	64	25 .
—	—	8	16	—	—	95	500	970	—	—	—	—	—	1	—	4	—	26 .
—	—	3	32	3	12	17	28	28	—	8	—	4	4	17	+	17	14	27 .
—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	3	4	30 .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	31 .

717　. . .

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Last uplift

694

	Kårehogen			Fjällbacka I	Udden II	Fiskebäckskil I	Fuglevik					Dal				Fjel	
	p. 618			p. 618	p. 618	p. 619	p. 620					p. 621				p. 6	
. .	1	2	3		5		1	2	3	4	5	1	2	3	4	1	
. .	×	× + 0.7	× + 1.5	33	27	22	31.5	32.5	33.5	34.5	35	32.5	33	33.5	34	27	2
. 1	2	—	3	24	5	165	160	140	96	12	36	45	65	52	30	10	1
. 3	+	—	+	+ +	3	3+	—	+	2	1	2	+	+	+	2	—	
. 5	—	—	—	—	2	10	18	6	6	12	—	—	—	—	—	2	
. 6	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	
. 7	—	—	+	—	—	—	—	—	—	+	—	—	—	—	—	—	
. 11	—	—	—	—	+	—	—	—	—	—	—	—	—	—	+	—	
. 20	1	4	—	—	—	—	1	1	1	1	—	1	1	—	+	+	
. 22	—	—	—	6	—	55	—	—	—	—	—	15	12	8	6	—	3
. 23	2	6	33	21	—	625	840	960	300	150	150	420	300	160	210	72	54
. 24	—	—	12	2	2	17	—	2	1	1	—	—	—	1	—	—	—
. 35	—	3	24	24	200	1 350	48	66	48	12	20	20	20	35	75	—	2
. 26	—	—	—	—	3	17	—	1	—	—	—	—	—	—	—	—	
. 27	3	3	5	—	5	22	77	55	35	6	9	22	44	80	40	5	6
. 29	—	—	—	—	—	—	—	1	1	+	+	—	—	—	—	—	—
. 81	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—

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718

Last uplift

695

5

Fjällbacka III				Fintorp II			Fossa	Hestrand II			Hamn I	Kristineberg I		Hovenäs I	Hovenäs II		
p. 622				p. 623			p. 623	p. 624			p. 624	p. 625		p. 626			
1	2	3	4	1	2	3	2	1	2	3		1	2		1	2	. . .
12	13	14	15	16	16.5	17	10.6	13	14	15	10	9.5	10	14	12.3	13	. . .
85	235	110	100	144	68	16	185	70	104	85	4	56	72	93	100	138	1 . .
—	—	2	4	1	—	—	4	4	4	2	+	—	—	1 +	—	1	3 . .
—	—	—	—	4	—	4	—	—	—	—	—	4	4	—	—	—	4 . .
—	—	8	10	—	—	12	4	—	12	5	—	4	—	6	—	5	5 . .
—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	6 . .
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	7 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	9 . .
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	10 . .
—	+	+	2	—	—	—	4	—	+	—	—	—	—	—	+	—	11 . .
—	—	—	—	—	+	—	—	—	—	1	—	—	—	—	—	—	18 . .
—	—	—	—	—	—	—	—	—	—	—	1	—	1	—	—	—	19 . .
—	1	8	+	10	4	+	—	3	8	12	1	8	4	—	—	—	20 . .
8	32	16	20	—	—	—	92	8	40	20	—	16	4	30	30	45	22 . .
400	1 040	1 040	1 150	760	400	140	760	620	1 080	1 125	6	260	300	135	375	495	23 . .
—	—	3	7	3	4	—	105	1	1	1	—	—	—	—	—	1	24 . .
90	240	1 000	2 145	680	200	60	2 210	160	820	475	6	76	160	540	135	360	25 . .
8	4	10	70	20	—	—	68	6	37	6	—	4	17	13	15	40	26 . .
32	110	140	115	20	27	18	75	110	105	42	2	18	12	16	16	14	27 . .
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	29 . .
—	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	30 . .
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	32 . .

719

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Last uplift

696

	Klevekilen I A	Fintorp I			Svenneby V	Slottet I	Hestrand I	Näset II	Svenneby VII			Svenneby I		Svenneby VI		
	p. 627	p. 627			p. 628	p. 628	p. 628	p. 629	p. 629							
. . .	3	1	2	3					1	2	3	1	2	1	2	
. . .	13	7	7.3	8	15	7	12	9	3.8	4.4	5	7	8	6.4	7.2	
. . 1	33	106	255	155	135	18	200	210	78	50	40	175	140	120	140	
. . 2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	
. . 3	—	1	—	3	—	2 +	+	1 +	4	3 +	3 +	2	—	2	2	
. . 4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	
. . 5	—	2	9	8	16	3	—	4	—	—	—	—	—	—	9	
. . 6	—	—	—	—	1	—	1	—	—	—	—	—	—	—	—	
. . 10	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	
. . 11	—	—	—	—	1	+	—	1	2	+	1	—	+	2	2	
. . 13	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	
. . 14	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	
. . 17	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	
. . 18	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	
. . 20	2	2	—	1	12	—	5	—	—	—	—	2	4	+	+	
. . 22	9	6	27	12	8	—	44	52	20	9	6	18	20	8	6	
. . 23	195	320	870	640	680	—	2 500	800	120	66	40	320	675	140	145	
. . 24	9	—	—	—	1	3	8	4	—	—	1	—	—	—	13	
. . 25	90	300	600	760	2 180	18	540	1 450	1 625	1 500	1 030	615	645	1 760	1 430	2
. . 26	3	19	18	30	30	4	14	125	180	140	40	50	40	105	100	
. . 27	13	55	135	200	265	28	68	96	65	34	45	130	185	135	155	
. . 28	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	
. . 29	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	

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720

Last uplift

697

5

Vik I	Varpet		Lök-ken	Åle-stran-den	Groten I		H a v i k				Slep-enden	Hermanö II	I A	I B	I C	
.631	p. 631		p. 632	p. 632	p. 632		p. 633				p. 633	p. 634				
	1	2			1	2	1	2	3	4			4	2		. . .
11	19	20	17	16	18.8	20	×	× +0.7	× +1.5	× +2.2	23	3	3.5	2.5	2.5	. . .
12	155	235	84	42	12	54	115	160	205	155	36	85	10	36	35	1 . .
1	—	+	+	+	+	+	—	1	1	—	2	2	—	2	—	3 . .
3	—	—	—	—	—	—	5	—	—	—	—	15	—	—	—	4 . .
—	5	20	4	—	—	—	—	—	—	35	—	6	—	—	8	5 . .
—	—	—	—	—	—	—	5	—	—	—	—	—	—	—	—	6 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	7 . .
1	+	—	+	+	—	—	+	—	—		—	+	—	—	+	11 . .
—	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	17 . .
3	2	16	—	—	8	6	1	8	7	7	—	2	—	2	3	20 . .
—	110	275	6	6	4	—	60	130	140	42	—	27	5	—	14	22 . .
40	1 000	925	110	27	60	245	925	1 550	1 405	1 260	—	690	80	200	190	23 . .
—	6	7	+	—	2	—	12	3	2	2	10	2	—	4	—	24 . .
00	110	375	54	90	40	128	285	450	450	455	130	1 280	—	40	20	25 . .
—	20	85	2	25	5	12	10	7	30	7	—	20	—	15	6	26 . .
4	40	50	77	46	16	9	80	100	150	60	15	38	+	23	20	27 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	29 . .
—	—	15	—	—	—	—	—	—	—	—	—	—	—	4	2	30 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	31 . .

3

. . . .

Last uplift

698

	Grundsund		Näset I	Rörvik		Vik IV	Florö	Hamn II		Tryggö		Hunnebo	Ålstenshan I		
				I	II										
	p. 635		p. 636	p. 636		p. 637	p. 637	p. 638		p. 638		p. 638	p. 639		
. . . .	1	2	3					1	2	1	2		1	2	3
. . .	1	1.5	4.7	9	5–10	1	5–10	6	7	2	3	1.5	2.8	3.4	4
. . 1	92	80	63	27	85	—	20	16	40	95	60	200	350	100	275
. . 3	2	2+	8	—	1	+	1	1	—	1	4	1+	2	1	1
. . 4	—	—	—	—	8	—	—	4	—	—	6	—	—	—	—
. . 5	—	—	—	—	—	—	—	12	—	—	—	10	30	15	—
. . 6	—	—	1	—	—	—	—	—	—	—	—	—	1	—	—
. . 11	1	+	4	+	+	+	+	—	—	4	6	1	—	—	—
. . 16	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
. . 18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. . 20	—	—	9	—	6	—	5	+	—	—	—	—	22	8	1
. . 21	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. . 22	8	—	20	3	—	—	—	—	5	50	63	15	—	—	—
. . 23	148	80	255	66	560	—	175	260	225	420	1 080	625	2 940	265	300
. . 24	+	—	13	+	—	—	—	—	5	4	—	9	—	—	1
. . 25	640	200	2 000	110	1 325	—	500	300	475	1 400	2 700	3 400	2 350	575	440
. . 26	78	12	13	12	8	—	6	9	2	68	44	60	2	15	35
. . 27	45	25	43	14	26	10	9	2	22	134	54	90	230	235	40
. . 30	—	—	—	—	—	—	—	4	5	—	—	—	—	—	—

. . . 722

Last uplift

699

5

ödbrug I	II	Groten II		Öde-gården		Lavösund I	Hovenäs III	Svenneby II	Vik II		Vikekilen I		Svenneby IV	Ålstenshamn II	
p. 640		p. 641		p. 641		p. 642	p. 642	p. 642	p. 643		p. 643		p. 644	p. 644	
		1	2	1	2		3		1	2	1	2		1	. . .
-15	14	7	8	×	+ 0.8	1.3	1.2	3	0.5	1	0.6	1.3	1.5	-0.2	. . .
4	90	36	80	3	35	4	—	145	68	16	56	32	95	160	1 . .
—	—	—	—	—	—	—	—	—	4	4	—	—	—	—	2 . .
2	—	+	5	2	+	1+	1	1	2	2	1	—	+	3	3 . .
1	—	—	3	—	—	—	—	—	—	—	—	—	—	—	4 . .
—	—	—	3	—	3	—	—	4	—	—	12	—	—	20	5 . .
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	6 . .
—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	9 . .
—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	10 . .
+	1	—	1	+	+	1	+	1	1	1	+	1	+	+	11 . .
—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	12 . .
—	1	1	—	—	—	—	—	3	+	—	—	—	14	—	20 . . .
—	—	—	6	—	3	—	—	8	—	—	8	—	—	5	22 . . .
2	75	28	140	15	215	—	—	700	32	20	100	32	340	700	23 . . .
—	1	—	—	—	4	—	—	1	—	—	—	—	—	4	24 . . .
22	33	—	100	18	140	5	—	300	480	260	240	280	560	1 300	25 . . .
2	54	—	13	—	4	2	—	4	38	13	28	—	36	50	26 . . .
38	58	6	26	5	13	3	2	180	13	36	9	13	190	95	27 . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	28 . . .
—	—	—	—	1	6	—	2	—	—	—	—	—	—	—	29 . . .

723 . . . .

5 **Modern**

. 700

	Smalsundet			Kristineberg II					Fiske-bäcks-kil II	Her-manö III	Ålstens-hamn II	Vik III	Vi kil II
	A	B	C	A	B	C	D	E					
. . . .	p. 499			p. 501					p. 503	p. 504	p. 505	p. 505	p.
. . . .	-1	-0.5	0	0.75	0.6	0.3	0.1	0	-0.2	0	0.4	0	0
. . . 1	18	—	48	42	24	15	8	6	—	110	25	—	8
. . . 3	+	+	3	2	+	—	2	—	+	1	—	—	+
. . . 4	—	—	—	—	—	15	—	—	—	—	—	—	—
. . . 5	2	—	—	3	—	—	—	—	—	—	—	—	—
. . 11	+	+	+	+	1	—	1	+	—	—	—	+	+
. . 20	+	—	+	—	9	6	—	1	—	1	1	—	2
. . 22	—	—	—	—	9	—	—	—	—	—	—	—	—
. . 23	28	+	225	180	105	110	60	25	1	400	140	—	32
. . 24	6	—	3	1	6	2	2	1	2	—	2	—	1
. . 25	70	10	260	240	660	40	77	13	2	220	130	175	150
. . 26	—	—	17	8	36	10	4	2	—	53	1	—	4
. . 27	90	4	55	25	50	7	14	1	—	38	27	10	85
. . 28	—	—	—	—	—	—	—	—	—	—	1	—	—
. . 29	1	—	6	—	—	—	—	—	1	—	—	—	1

. . . 724

Modern

701

5

Continued from page

enne- y III		Skarvik	Strömsund	Bärviken	Lindholmen I	II	Humlesäcken	Flatholmen I	II	Gåsöredd I	II	III	IV	Gullmaren				
	B																	
. 506		p. 507	p. 509	p.510	p. 510		p. 511	p. 513		p. 514				p. 517		Number of samples		
	0	0	-5	-15	-15	-20	-30	-30	-30	-30	-35	-30	-30	-70		Height »		
0	14	15	2	—	5	10	17	20	36	—	1	—	1	6	1	1 *Onoba aculeus-striata*	a^lbl	s
																2 » *vitrea*	b^ll	d
–	1	—	2	—	—	—	—	—	—	1	+	1	+	—	3	3 *Ostrea edulis*	b^ll	sd
																4 *Parthenia interstincta*	b^ml	d
–	—	—	—	—	—	—	1	—	—	—	—	—	—	—	5	5 » *spiralis*	bl	d
																6 *Patella vulgata*	b	s
–	—	2	+	—	—	—	—	1	—	—	—	—	—	—	7	7 *Pecten islandicus*	ab^h	d
–	—	—	—	—	—	—	+	+	—	—	—	1	2	—	8	8 » *opercularis*	b^ml	d
–	—	—	—	—	—	—	+	+	1	—	—	—	—	+	9	9 » *septemradiatus*	bl	d
–	—	—	—	—	1	+	1	5	1	—	1	1	+	+	10	10 » *tigrinus*	bl	d
+	+	—	2	—	+	+	2	+	+	1	+	2	1	+	11	11 » *varius*	b^ll	sd
																12 *Philine quadrata*	a^lbl	d
																13 *Portlandia arctica*	a^h	sd
–	1	—	—	—	—	—	—	—	—	—	—	—	—	—	14	14 » *lenticula*	w	d
																15 » *tenuis*	b^ml	d
																16 » sp.		
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	17	17 *Psammobia ferroeensis*	bl	d
																18 » *vespertina*	l	s
–	—	—	—	1	—	—	—	—	—	—	—	—	—	—	19	19 *Puncturella noachina*	ab	d
5	13	+	—	+	—	—	+	—	—	—	—	—	—	+	20	20 *Purpura lapillus*	a^lb	s
																21 *Rissoa albella*	b^ll	s
—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	22	22 » *inconspicua*	bl	sd
10	90	10	—	—	—	—	14	8	—	—	—	1	—	—	23	23 » *interrupta*	a^lbl	sd
—	7	—	—	—	—	—	—	—	3	—	—	—	—	—	24	24 » *membranacea*	b^ml	s
80	240	275	1	—	5	4	22	8	9	—	—	—	—	2	25	25 » *parva*	b^ll	sd
—	—	3	—	—	—	—	—	—	—	—	—	—	—	2	26	26 » *violacea*	b^ml	sd
42	28	2	4	1	35	50	45	42	65	1	13	22	13	16	27	27 *Saxicava arctica*	(w) a	sd
—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	28	28 *Scalaria communis*	b^ll	d
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29	29 *Scrobicularia piperata*	b^ll	d
																30 *Skenea planorbis*	w	s
																31 *Solen ensis*	bl	sd
																32 *Spirialis retroversus*	bl	s

Continued on page

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Continued from page 702

				Ancylus sinking						Ancylus uplift							
				Gudebo	Skârbo			Knutsdalen		Bredhult		Skärjedalen	Oxtorp	Ullerö	Tose		
				p. 598	p. 599			p. 600		p. 600		p. 601	p. 602	p. 603	p. 604		
		Number of samples		—	1	2	3	1	2	1	2				1	2	3
		Height »		46.3	44.2	45.2	46	53	54	70	71	63	49	59	55.8	56.4	57
b^{l}l	sd	1 *Tapes aureus*															
l	s	2 » *decussatus*															
bl	s	3 » *pullastra*	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
b^{l}l	sd	4 » *virgineus*	4	—	—	—	—	—	--	—	—	—	8	—	—	—	—
		5 » sp.															
a^{l}bl	sd	6 *Tectura virginea*	6	—	7	3	—	2	$^{1}/_{2}$	4	1	1	—	—	20	1	1
bl	d	7 *Tellimya ferruginosa*															
b^{l}l	sd	8 *Tellina crassa*															
b^{m}l	d	9 » *pusilla*															
a^{l}bl	d	10 *Terebratulina caput serpentis*															
b^{m}l	sd	11 *Thracia papyracea*															
b^{m}b^{l}	sd	12 » *villosiuscula*	12	—	—	—	—	—	—	—	—	2	$^{1}/_{2}$	—	+	+	—
		13 » sp.	13	—	—	—	—	—	—	—	—	—	—	—	4	—	—
b^{l}l	sd	14 *Triforis perversa*															
b^{l}l	sd	15 *Trivia europea*															
abm	d	16 *Trophon clathratus*															
abm	d	17 » *truncatus*															
b^{l}l	d	18 *Turbonilla indistincta*															
b^{l}l	sd	19 » *lactea*															
b^{m}l	d	20 *Turritella terebra*															
b^{l}l	d	21 *Utriculus mammillatus*															
bl	sd	22 » *truncatulus*	22	—	—	—	—	—	—	—	—	—	—	—	12	—	—
b^{m}l	d	23 » *umbilicatus*															
		24 » sp.															
w	sd	25 *Velutina laevigata*															
b^{m}l	d	26 *Venus fasciata*															
bl	sd	27 » *gallina*															
bl	sd	28 » *ovata*															
a^{l}bl	sd	29 *Verruca stroemia*	29	—	65	13	18	4	6	6	5	90	1	—	—	—	—
b^{l}l	d	30 *Vola maxima*															
w	d	31 *Waldheimia cranium*															

Ancylus uplift
703

Udden I					Lavö			Fyka					Lersten					6
p. 605					p. 605			p. 606					p. 607					. . .
1	2	3	4	5	1	2	3	1	2	3	4	5	1	2	3	4	5	. . .
33	34	35	35.5	36	18	19	20	20.2	21	21.7	22.5	23	15	16	17	18	19	. . .
—	—	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	4 . .
6	3	2	—	2	11	—	24	—	4	—	7	1	8	5	—	—	—	6 . .
—	—	—	—	—	—	—	6	—	—	—	—	—	—	—	—	—	—	13 . .
3	—	3	6	6	—	—	6	—	—	—	—	—	—	—	—	—	—	14 . .
—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	18 . .
—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	—	—	—	24 . .
—	—	—	—	—	½	—	18	—	—	—	—	—	—	—	—	—	—	28 . .
3	25	25	44	115	—	—	68	—	5	10	15	2	—	+	6	6	—	29 . .

6

Ancylus uplift

704

	Klevekilen II	Klevekilen I A		Klevekilen I B				Fossa	Röd			Fjällbacka II			Sörgården	Tången II	Näset	
	p. 608	p. 608						p. 610	p. 610			p. 611			p. 612	p. 612	p. 612	
. .		1	2	1	2	3	4	1	1	2	3	1	2	3		3	1	2
. .	17	12	12.6	11.2	12	12.5	13	10	9	10	10.6	8.5	9.2	10	2	2	4	4.
. 1	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—
. 4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	
. 5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	
. 6	2	27	14	—	8	10	6	40	15	14	12	—	—	—	—	19	34	1
. 8	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
. 11	—	3	5	—	2	4	2	—	—	—	—	—	—	—	—	—	—	—
. 12	—	—	—	—	—	—	1	—	—	—	—	—	—	1/2	—	—	1	
. 13	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—
. 14	—	3	3	—	—	—	—	4	45	—	—	—	—	—	—	—	—	—
. 16	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. 18	—	3	3	—	—	—	—	16	—	—	—	—	—	—	—	—	—	—
. 22	—	—	3	—	—	—	—	—	75	—	—	—	—	—	—	3	15	1
. 27	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
. 28	2	25	12	—	1	9	11	—	55	—	—	—	—	—	20	4	—	
. 29	5	—	—	—	2	10	2	44	30	2	8	—	+	9	—	—	50	3

Tapes sinking

705

6

Ellene				Hovenäs III		Slottet II			Tången I			Udden II				Solbräcke		. . .
p. 613				p. 614		p. 615			p. 616			p. 616				p. 617		
1	2	3	4	1	2	1	2	3	1	2	3	1	2	3	4	1	2	. . .
2.3	3.3	3.9	4.5	0.5	0.8	14.5	15.2	16	18.4	19.2	20	24.2	25	25.7	26.5	23.5	24	. . .
—	—	—	—	1	—	—	—	—	—	1	—	—	—	—	—	2	+	1 . .
—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—	—	3 . .
—	—	—	—	1	4	—	4	—	—	—	—	—	—	—	+	—	—	5 . .
—	—	27	28	—	—	42	50	34	1	4	2	—	16	1	10	37	60	6 . .
—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	7 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	9 . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	12	—	—	—	11 . .
—	—	—	—	—	—	7	11	—	—	—	—	—	—	1	3	2	4	12 . .
—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	13 . .
—	—	—	3	2	—	3	—	—	—	1	—	—	8	4	—	—	—	14 . .
—	—	3	3	—	—	—	—	—	3	—	—	—	—	—	—	—	—	18 . .
—	—	—	—	1	+	+	2	4	—	—	—	—	—	—	—	—	—	20 . .
—	—	—	—	—	—	—	3	—	—	3	5	—	—	4	4	9	16	22 . .
—	—	—	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	23 . .
—	—	—	—	—	—	—	—	2	—	—	1	—	—	—	—	—	—	27 . .
—	—	2	8	17	6	8	14	11	3	9	9	—	11	13	9	5	6	28 . .
2	8	205	200	1	—	7	6	220	+	8	54	43	475	1 390	270	63	67	29 . .

6

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Last uplift

706

	Kårehogen			Fjäll-backa I	Ud-den II	Fiske-bäcks-kil I	Fuglevik					Dal				Fjell
	p. 618			p. 618	p. 618	p. 619	p. 620					p. 621				p. 621	
. .	1	2	3		5		1	2	3	4	5	1	2	3	4	1	2
. .	×	× + 0.7	× + 1.5	33	27	22	31.5	32.5	33.5	34.5	35	32.5	33	33.5	34	27	28
. 1	—	2	2	—	2	9	1	—	—	—	+	—	—	—	—	—	—
. 2	—	—	—	—	1	—	—	—	+	—	+	—	—	—	—	—	—
. 3	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. 4	—	—	—	—	—	1	—	—	—	—	—	—	+	—	—	—	2
. 6	+	i	—	3	—	—	95	55	30	20	23	38	35	30	40	—	14
. 12	—	—	—	3	—	+	—	+	—	—	—	—	—	+	+	—	2
. 13	—	—	—	—	—	—	—	—	3	3	2	—	—	2	—	—	—
. 14	—	—	—	—	5	—	—	—	—	—	—	—	—	—	—	—	—
. 18	—	—	—	—	1	—	—	—	—	12	—	—	—	—	—	—	8
. 22	—	—	—	6	—	5	24	12	12	—	5	3	8	—	—	2	8
. 27	+	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—
. 28	45	9	—	11	1	4	25	7	11	5	12	3	8	2	6	—	2
. 29	—	20	10	10	18	—	115	100	80	20	11	64	60	114	25	—	2

Last uplift

707

6

Fjällbacka III			Fintorp II			Fossa	Hestrand II			Hamn I	Kristineberg I		Hovenäs I	Hovenäs II		
p. 622			p. 623			p. 623	p. 624			p. 624	p. 625		p. 626			
2	3	4	1	2	3	2	1	2	3		1	2		1	2	. . . .
13	14	15	16	16.5	17	10.6	13	14	15	10	9.5	10	14	12.3	13	. . . .
2	2	3	—	5	1	—	—	—	1	—	—	—	—	—	—	1 . . .
—	—	—	1	+	1	—	—	—	—	—	—	—	—	—	—	2 . .
—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—	4 . . .
—	—	—	—	—	—	—	2	—	—	—	—	—	2	—	2	5 . . .
46	13	20	28	14	2	25	17	3	8	7	6	16	2	16	16	6 . . .
—	1	—	—	—	—	2	—	—		—	—	—	—	3	—	9 . .
—	—	—	—	—	4	—	—	4	—	—	—	—	2	3	12	11 . . .
2	—	—	—	1	—	—	—	—	—	—	—	1	—	--	1	12 . . .
—	—	—	—	—	—	—	3	1	1	—	4	—	—	—	—	13 . . .
—	—	25	—	—	4	8	4	4	6	—	—	—	—	—	3	14 . . .
4	4	5	—	—	—	—	4	—	—	1	—	—	—	—	—	18 . . .
—	—	5	—	—	—	—	—	—	5	—	—	—	—	—	—	19 . . .
—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	20 . . .
—	—	—	—	—	—	—	—	4	—	—	—	—	—	—	—	21 . . .
48	4	5	4	2	—	12	20	—	10	—	4	12	—	—	3	22 . . .
—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	27 . . .
+	2	+	—	2	—	1	—	6	9	6	4	7	7	22	28	28 . . .
350	85	35	23	65	55	22	55	85	55	12	20	22	—	47	46	29 . . .
—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	31 . . .

6

Last uplift

708

. . .

	Klevekilen I A	Fintorp I			Svenneby V	Slottet I	Hestrand I	Näset II	Svenneby						
									VII			I		VI	
	p. 627	p. 627			p. 628	p. 628	p. 628	p. 629	p. 629						
. . .	3	1	2	3					1	2	3	1	2	1	2
. . .	13	7	7.3	8	15	7	12	9	3.8	4.4	5	7	8	6.4	7.2
. . 1	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—
. . 4	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
. . 5	2	—	—	—	—	—	—	—	—	—	—	—	—	—	+
. . 6	32	8	24	32	9	1	46	60	24	36	20	18	20	33	55
. . 9	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—
. . 11	3	—	—	—	—	—	10	8	—	2	—	—	—	—	—
. . 12	—	1	—	—	—	—	—	1	—	+	—	2	2	—	—
. . 14	—	—	3	—	8	3	8	4	—	3	3	3	—	—	—
. . 18	—	—	—	—	—	—	12	—	—	—	—	—	—	—	6
. . 19	—	—	—	—	—	—	—	—	—	3	—	—	—	—	3
. . 20	—	—	—	—	—	1	—	—	+	1	+	—	—	+	—
. . 21	—	—	—	—	—	—	—	—	—	—	—	6	3	—	—
. . 22	3	—	9	4	16	3	8	—	—	—	—	6	6	4	—
. . 25	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
. . 27	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—
. . 28	13	2	—	—	4	4	11	52	3	4	4	3	3	2	4
. . 29	325	105	380	185	10	38	230	190	67	4	3	275	300	90	100

Last uplift **6**

709 . . . . .

	Varpet		Lökken	Ålestranden	Groten I		Havik				Slependen	Hermanö II	Hermanö I A	B	C	
1	p. 631		p. 632	p. 632	p. 632		p. 633				p. 633	p. 634				
	1	2			1	2	1	2	3	4			4	2		. . . . .
	19	20	17	16	18.8	20	×	× +0.7	× +1.5	+2.2	23	3	3.5	2.5	2.5	. . . . .
	—	—	—	—	—	—	+	—	—	—	—	+	—	1	1	1 . . . .
	—	—	—	—	—	+	—	—	—	—	—	—	—	—	1	3 . . . .
	—	—	—	—	2	—	—	—	2	—	—	—	—	—	—	4 . . . .
	4	3	1	—	—	—	5	—	—	—	—	+	—	1	1	5 . . . .
	78	77	68	24	45	60	112	80	66	88	1	20	5	4	25	6 . . . .
	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—	7 . . . .
	—	—	—	—	—	—	—	—	—		—	—	—	—	1	9 . . .
	—	—	—	—	2	—	—	—	—	—	—	—	—	3	—	11 . . .
	—	+	—	—	+	4	6	10	28	+	—	—	—	5	1	12 . . .
	5	8	—	—	2	—	—	—	—	—	—	—	—	—	3	13 . . .
	5	—	1	—	—	2	—	—	6	7	6	3	—	—	—	14 . . .
	—	—	—	3	—	—	—	—	—	—	—	—	—	—	—	19 . . .
	—	—	2	—	—	—	—	—	—	—	—	—	—	2	—	20 . . .
	—	—	—	—	—	—	—	—	6	7	—	—	—	—	—	21 . . .
	15	35	10	3	—	—	5	6	6	—	—	9	10	8	2	22 . . .
	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	25 . . .
	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	27 . . .
1	57	87	13	30	15	25	45	80	50	35	3	5	—	3	5	28 . . .
—	70	77	2	—	23	215	80	125	150	130	—	11	27	16	45	29 . . .

6

Last uplift
710

. . . .	Grund-sund		Näset I	Rörvik I	Rörvik II	Vik IV	Florö	Hamn II		Tryggö		Hun-nebo	Ålstensham I		
	p. 635		p. 636	p. 636		p. 637	p. 637	p. 638		p. 638		p. 638	p. 639		
. . . .	1	2	3					1	2	1	2		1	2	3
. . . .	1	1.5	4 7	9	5-10	1	5–10	6	7	2	3	1.5	2.8	3.4	4
. . 1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
. . 4	—	—	3	—	—	—	—	—	1	—	—	—	—	—	—
. . 5	—	—	—	+	1	—	—	—	—	3	—	1	—	3	—
. . 6	30	3	8	17	11	—	12	4	16	25	—	24	4	20	9
. . 9	—	—	—	—	—	—	—	—	—	3	—	—	—	—	—
. . 11	—	—	—	2	—	—	—	—	—	2	—	—	—	—	—
. . 13	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—
. . 14	28	16	7	—	—	—	—	1	15	—	—	5	12	—	5
. . 19	—	—	—	3	—	—	5	—	—	3	—	—	—	—	—
. . 20	—	—	—	+	5	—	—	—	—	—	—	1	—	—	—
. . 22	12	8	9	3	4	—	—	—	—	6	3	10	18	—	—
. . 27	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—
. . 28	11	3	—	3	2	4	11	+	2	7	4	7	—	3	—
. . 29	—	—	10	7	2	—	205	—	6	58	12	—	15	17	50
. . 30	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Last uplift
711

6

ödbrug I	II	Groten II		Öde- gården		Lavö- sund I	Hove- näs III	Sven- neby II	Vik II		Vike- kilen I		Sven- neby IV	Ålstens- hamn II	
p. 640		p. 641		p. 641		p. 642	p. 642	p. 642	p. 643		p. 643		p. 644	p. 644	
		1	2	1	2		3		1	2	1	2		1	. . . .
-15	14	7	8	×	× + 0.8	1.3	1.2	3	0.5	1	0.6	1.3	1.5	-0.2	. . . .
—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1 . . .
—	—	—	—	—	—	—	—	1/2	—	—	—	—	—	—	4 . . .
—	—	—	—	—	—	1	2	—	—	+	+	—	3	—	5 . . .
8	120	12	20	6	19	—	—	4	5	1	13	9	25	40	6 . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	1	3	9 . . .
—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	11 . . .
—	—	—	—	—	—	+	—	—	—	—	—	—	—	1	12 . . .
—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	13 . . .
1	3	—	3	—	6	—	—	7	8	8	8	4	—	5	14 . . .
—	—	—	+	—		—	—	—	1	2	—	—	—	—	20 . . .
—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	21 . . .
—	3	—	—	—	—	—	—	4	—	—	4	—	4	10	22 . . .
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	27 . . .
6	26	6	45	2	12	1	1	1/2	40	11	8	10	—	27	28 . . .
—	65	—	18	—	—	—	—	7	2	—	285	10	485	40	29 . . .

6

Modern

712

	Smalsundet A	Smalsundet B	Smalsundet C	Kristineberg II A	Kristineberg II B	Kristineberg II C	Kristineberg II D	Kristineberg II E	Fiskebäckskil II	Hermanö III	Ålstenshamn II	Vik III	Vikekilen II
. . .	p. 499			p. 501					p. 503	p. 504	p. 505	p. 505	p. 506
. .	-1	-0.5	0	0.75	0.6	0.3	0.1	0	-0.2	0	0.4	0	0
. 1	1	—	1	—	—	—	1	—	—	—	—	—	—
. 5	—	+	—	—	—	—	—	—	—	—	—	—	1
. 6	4	—	1	10	20	8	11	4	—	35	10	6	4
. 13	—	—	—	3	—	—	—	—	—	—	—	—	—
. 14	6	—	10	—	3	—	—	1	—	—	10	10	—
. 18	—	—	—	3	—	5	—	—	—	—	—	—	—
. 20	—	—	—	—	—	1	—	—	—	—	—	—	—
. 22	—	—	9	—	6	5	—	—	—	4	—	—	4
. 27	—	—	—	3	2	—	—	1	—	—	—	—	—
. 28	6	+	7	15	6	5	6	1	—	12	—	17	9
. 29	—	+	15	230	108	20	20	1	—	300	70	6	2

Modern

713

6

. . . . Continued from page

Svenneby III A	Svenneby III B	Skarvik	Strömsund	Bärviken	Lindholmen I	Lindholmen II	Humlesäcken	Flatholmen I	Flatholmen II	Gåsöredd I	Gåsöredd II	Gåsöredd III	Gåsöredd IV	Gullmaren					
p. 506		p. 507	p. 509	p. 510	p. 511		p. 511	p. 513		p. 514				p. 517			Number of samples		
0	0	0	-5	-15	-15	-20	-30	-30	-30	-30	-35	-30	-30	-70			Height ›		
—	½	—	+	—	—	—	—	—	—	1	—	—	—	—	1	1	*Tapes aureus*	b^{l}l	sd
																2	› *decussatus*	l	s
—	—	—	9	—	—	—	—	—	—	—	—	—	—	—	3	3	› *pullastra*	bl	s
																4	› *virgineus*	b^{l}l	sd
½	—	—	—	—	—	+	—	—	—	—	—	—	—	+	5	5	› sp.		
5	10	—	5	1	1	7	12	2	30	1	1	1	4	28	6	6	*Tectura virginea*	a^{l}bl	sd
																7	*Tellimya ferruginosa*	bl	d
																8	*Tellina crassa*	b^{l}l	sd
																9	› *pusilla*	b^{m}l	d
—	—	—	—	—	—	—	+	—	2	—	—	—	—	2	10	10	*Terebratulina caput serpentis*	a^{l}bl	d
—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	11	11	*Thracia papyracea*	b^{m}l	sd
—	—	—	—	—	—	—	1	—	—	+	—	—	—	—	12	12	› *villosiuscula*	b^{m}bl	sd
—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	13	13	› sp.		
—	4	3	—	1	2	4	—	—	3	—	—	—	—	6	14	14	*Triforis perversa*	b^{l}l	sd
—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	15	15	*Trivia europea*	b^{l}l	sd
																16	*Trophon clathratus*	abm	d
—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	17	17	› *truncatus*	abm	d
																18	*Turbonilla indistincta*	b^{l}l	d
																19	› *lactea*	b^{l}l	sd
—	—	+	—	1	3	4	7	8	12	43	33	27	22	2	20	20	*Turritella terebra*	b^{m}l	d
																21	*Utriculus mammillatus*	b^{l}l	d
—	2	—	—	—	2	—	2	—	4	—	—	—	—	—	22	22	› *truncatulus*	bl	sd
																23	› *umbilicatus*	b^{m}l	d
																24	› sp.		
—	—	—	—	—	—	1	—	—	1	—	—	—	—	—	25	25	*Velutina laevigata*	w	sd
—	—	—	—	—	—	—	+	—	—	—	—	—	—	—	26	26	*Venus fasciata*	b^{m}l	d
½	—	—	—	2	2	—	—	—	—	2	1	1	2	1	27	27	› *gallina*	bl	sd
7	1	½	5	10	33	65	26	53	55	4	25	15	20	37	28	28	› *ovata*	bl	sd
155	56	9	1	1	15	20	60	80	58	2	2	12	3	55	29	29	*Verruca stroemia*	a^{l}bl	sd
																30	*Vola maxima*	b^{l}l	d
																31	*Waldheimia cranium*	w	d

Synonyms.

In the present paper the names that are best known in geological literature have been used. The most important full or partial synonyms are given below. The names used are in *italics*.

Abra—*Scrobicularia*—Syndosmia
Acmaea—*Lepeta*—Scutellina—*Tectura*
Alvania—*Onoba*—*Rissoa*
Amauropsis—*Natica*
Anomia squamula L.—*A. ephippium* L.
Antalis—*Dentalium*
Arcinella—*Panopea*—*Saxicava*
Artemis—*Dosinia*
Astarte—Tridonta
» compressa Mont.—*A. Montagui* Dillw.—Nicania banksi Leach
Axinus—Thyasira

Balanus balanus L.—*B. porcatus* da Costa
Bela—Lora—Pleurotoma
Bittium—*Cerithiopsis*—Cerithium—*Triforis*
Boreochiton *Chiton*—Tonicella—Trachydermon
Bulla—*Diaphana*—*Utriculus*

Callochiton—*Chiton*
Camponectes—*Pecten*
Cardium—Laevicardium—Serripes
Cerithiopsis—*Bittium*
Cerithium—*Bittium*—*Triforis*
Chiton—*Boreochiton*—*Callochiton*—*Craspedochilus*—Hanleyia—*Lepidopleurus* —Leptochiton —Leptochitona—*Lophyrus*—Tonicella—Trachydermon
Chlamys—*Pecten*
Cingula—*Hydrobia*
Clathurella—Defrancia—Philbertia
Conulus—*Gibbula*—Trochus
Craspedochilus—*Chiton*—Leptochiton
Crenella—*Modiolaria*
Cultellus—*Solen*
Cyamium—Turtonia
Cylichna—*Utriculus*
Cypraea—*Trivia*

Dentalium—Antalis—*Siphonodentalium*
Defrancia—*Clathurella*
Diaphana—Bulla—*Utriculus*
Dosinia—Artemis

Ensis—*Solen*
Epitonium—Scala—*Scalaria*
Eulima—Melanella
Euspira—*Lunatia*
Fusus—Fusinus—*Neptunea*

Gibbula—Lirularia—Trochus

Hanleyia—*Chiton*
Helcion—*Nacella*
Hinnites—*Pecten*
Hydrobia—*Cingula*

Jeffreysia—Rissoella

Laevicardium—*Cardium*
Lepeta—Pilidium—Scutellina
Lepidopleurus—*Chiton*
» *asellus* L.—L. cinereus L.
Leptochiton—*Chiton*—*Craspedochilus*—*Boreochiton*
Leptochitona—*Chiton*
Lirularia—*Gibbula*
Littorina saxatilis Olivi—*L. rudis* Maton
Lophyrus—*Chiton*
Lora—*Bela*
Lunatia—Euspira—*Natica*
» *groenlandica* Beck—L. pallida Brod. & Sow.
Lutraria—*Scrobicularia*

Macoma—*Tellina*
Margarita—Margarites
Melanella—*Eulima*
Modiola—*Mytilus*—Volsella
Modiolaria—*Crenella*—Musculus
Mytilus—Modiola—Volsella

Nacella—Helcion
Natica—*Lunatia*—*Amauropsis*
» clausa Brod. & Sow. under *N. affinis* Gmel.
Neptunea—Fusus—*Sipho*
» antiqua L. under *N. despecta* L.
Nicania banksi Leach—Astarte compressa Mont.—*A. montagui* Dillw.

Palliolum—*Pecten*
Panopea—*Arcinella*—*Saxicava*
Parthenia—*Turbonilla*
Patella—*Tectura*
Pecten—Camptonectes—Chlamys—*Hinnites*—Palliolum—*Vola*
Philbertia—*Clathurella*
Pholas—*Zirphaea*

Pilidium—*Lepeta*—Scutellina—*Tectura*
Pleurotoma—*Bela*
Polytropa—*Purpura*
Portlandia—*Yoldia*
Protothaca—*Tapes*
Pulsellum—*Siphonodentalium*

Retusa—*Utriculus*
Rissoa—*Alvania*—*Onoba*—Rissostomia
Rissoella—*Jeffreysia*

Saxicava—*Arcinella*—*Panopea*
» *arctica* L.—S. pholadis L.—S. rugosa L.
Scala—*Scalaria*—Epitonium
Scalaria clathrus L.—*S. communis* LAM.
Scrobicularia—*Abra*—Lutraria—Syndosmia
Scutellina—Acmaea—*Lepeta*—Pilidium—*Tectura*
Serripes—*Cardium*
Sipho—*Neptunea*
Siphonodentalium—*Dentalium*—Pulsellum
» *lobatum* SOW.—S. vitreum M. SARS
Solen—*Cultellus*—Ensis
Syndosmia—*Abra*—*Scrobicularia*

Tapes—Protothaca—*Venus*
Tectura—Acmaea—*Patella*—Scutellina
Tellina—*Macoma*
Thyasira—*Axinus*
Timoclea—*Venus*
Tonicella—*Boreochiton*
Trachydermon—*Boreochiton*—*Craspedochilus*—*Lophyrus*
Tridonta—*Astarte*
Triforis—*Bittium*
Trivia—Cypraea
Trochus—*Conulus*—*Gibbula*
Turbonilla—*Parthenia*
Turritella communis LAM.—*T. terebra* L.
Turtonia—*Cyamium*

Utriculus—Bulla—*Cylichna*—*Diaphana*—Retusa

Venus—*Tapes*—Timoclea
Vola—*Pecten*
Volsella—Modiola—*Mytilus*

Yoldia—*Portlandia*
» limatula SAY—variety of *Y. hyperborea* LOVÉN

Zirphaea—*Pholas*

Conversion tables.

	Cm to inches	M to feet	M to fathoms	Km to miles	Fathoms to m
1=	0.39370	3.28083	0.5468	0.62137	1.8288
2=	0.78740	6.56167	1.0936	1.24274	3.6576
3=	1.18110	9.84250	1.6404	1.86411	5.4864
4=	1.57480	13.12333	2.1873	2.48548	7.3152
5=	1.96850	16.40417	2.7341	3.10685	9.1440
6=	2.36220	19.68500	3.2809	3.72822	10.9728
7=	2.75590	22.96583	3.8277	4.34959	12.8016
8=	3.14960	26.24667	4.3745	4.97096	14.6304
9=	3.54330	29.52750	4.9213	5.59233	16.4592

1 inch = 2.54000 cm
1 foot = 0.304800 m
1 mile = 1.60935 km
1 fathom = 6 feet

$C° = \frac{5}{9} (F°-32°)$
$F° = \frac{9}{5} C° + 32°$

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Åsgård	148	585
Bärviken	77	510
Bonden		509
Brandshult		546
Bredhult	140	600
Dal	155	621
Ellene	101	613
Fintorp I	109	627
» II	110	623
Fiskebäckskil I	72	619
» II	70	503
» III	71	503
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» II	131	611
» III	130	622
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Florö	133	637
Fossa	67	610, 623
Fuglevik	157	620
Furuholmen	20	517
Fyka	96	606
Gåsöredd I—V	68	514
Glimsås	57	595
Gråskär	79	514
Groten I	151	632
» II	152	641
Grundsund	66	635
Gudebo	138	598
Gullmaren		517
Hagtorn	146	586
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Hästekälla	55	591, 604
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Hunnebo	97	638
Huseby	56	595
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Kilebråten	150	583
Kilen	149	585
Klevekilen I	85	608, 627
» II	84	608
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Krappetolien	145	584
Kristineberg I	73	625
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Lavösund I	61	642
Lersten	132	607
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Skärjedalen	141	601
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» II	123	615
Smalsundet	75	499
Solbräcke	112	617
Sörgården	49	612
Sparöd	111	588
Stångenäs		549
Stensbo	54	593
Strömsund	76	509
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» II	113	643
Svenneby III	114	506
» IV	115	644
» V	117	628
» VI	119	630
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Location of the shell beds.

The location of the shell beds examined is shown in the accompanying maps. A number of the beds are indicated in the geological maps (De Geer, 1902; Svedmark, 1902; Lindström, 1902; Blomberg, 1902). Forty-six beds were described by the writer in 1917.

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70	Fiskebäckskil II	503
71	» III	503
72	» I	619
73	Kristineberg I	625
74	» II	501
75	Smalsundet	499
76	Strömsund	509
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129	Fjällbacka I	618
130	» III	622
131	» II	611
132	Lersten	607
133	Florö	637
134	Skistad	590
135	Nordby	590
136	Skårbo	599
137	Lur	592
138	Gudebo	598
139	Oxtorp	602
140	Bredhult	600
141	Skärjedalen	601
142	Skärje	602
143	Varpet	631
144	Lindal	587
145	Krappetolien	584
146	Hagtorn	586
147	Moen	583
148	Åsgård	585
149	Kilen	585
150	Kilebråten	583
151	Groten I	632
152	» II	641
153	Tose	604
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155	Dal	621
156	Ödegården	641
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158	Rödbrug I	640
159	» II	640
160	Ålestranden	632
161	Fjelle	621
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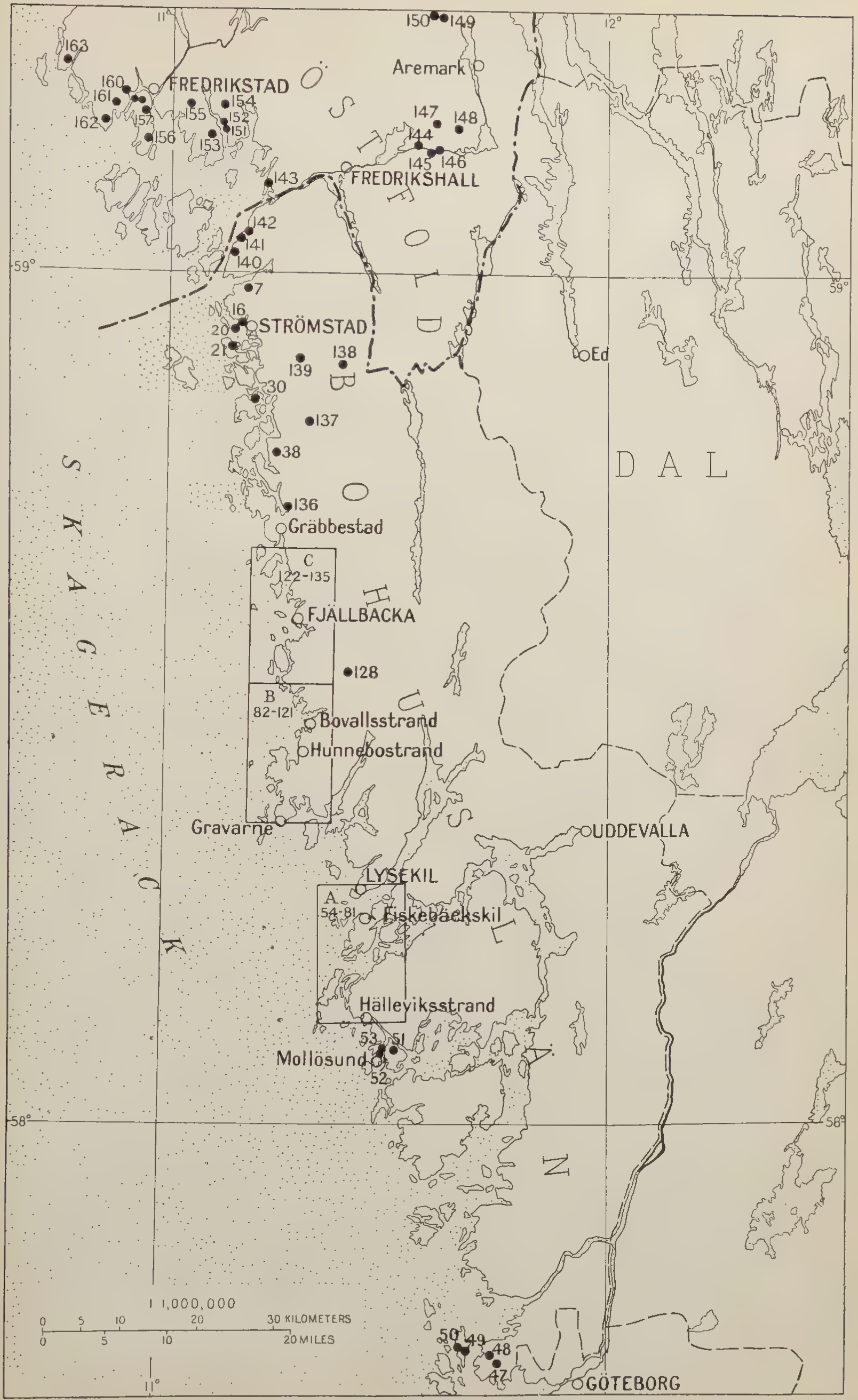

Fig. 3. The region between Göteborg and the Oslofjorden. Position of the examined shell beds.

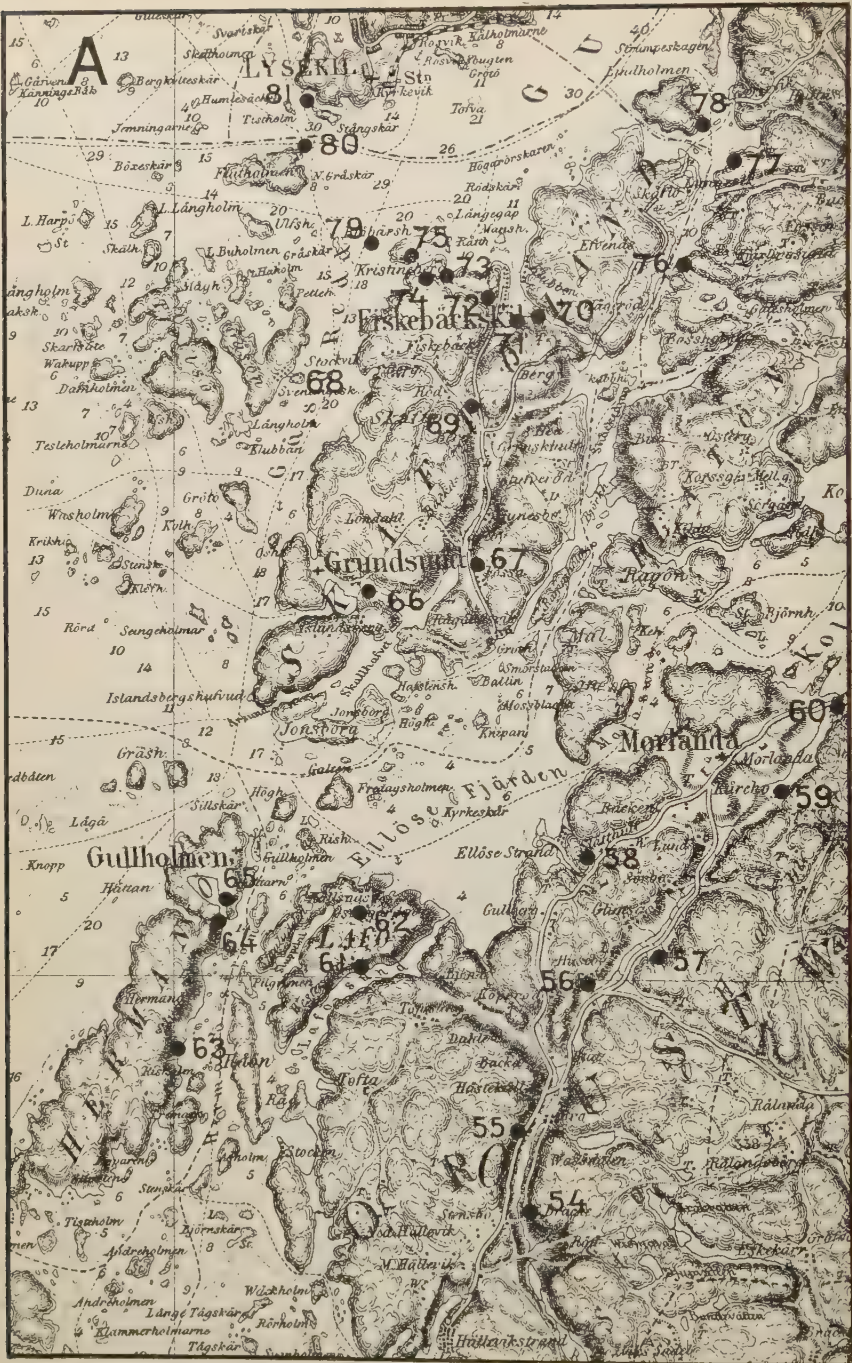

Fig. 4. Position of the shell beds examined in the region Hällevikstrand—Lysekil (beds 38, 54—81). Scale 1 : 100,000.

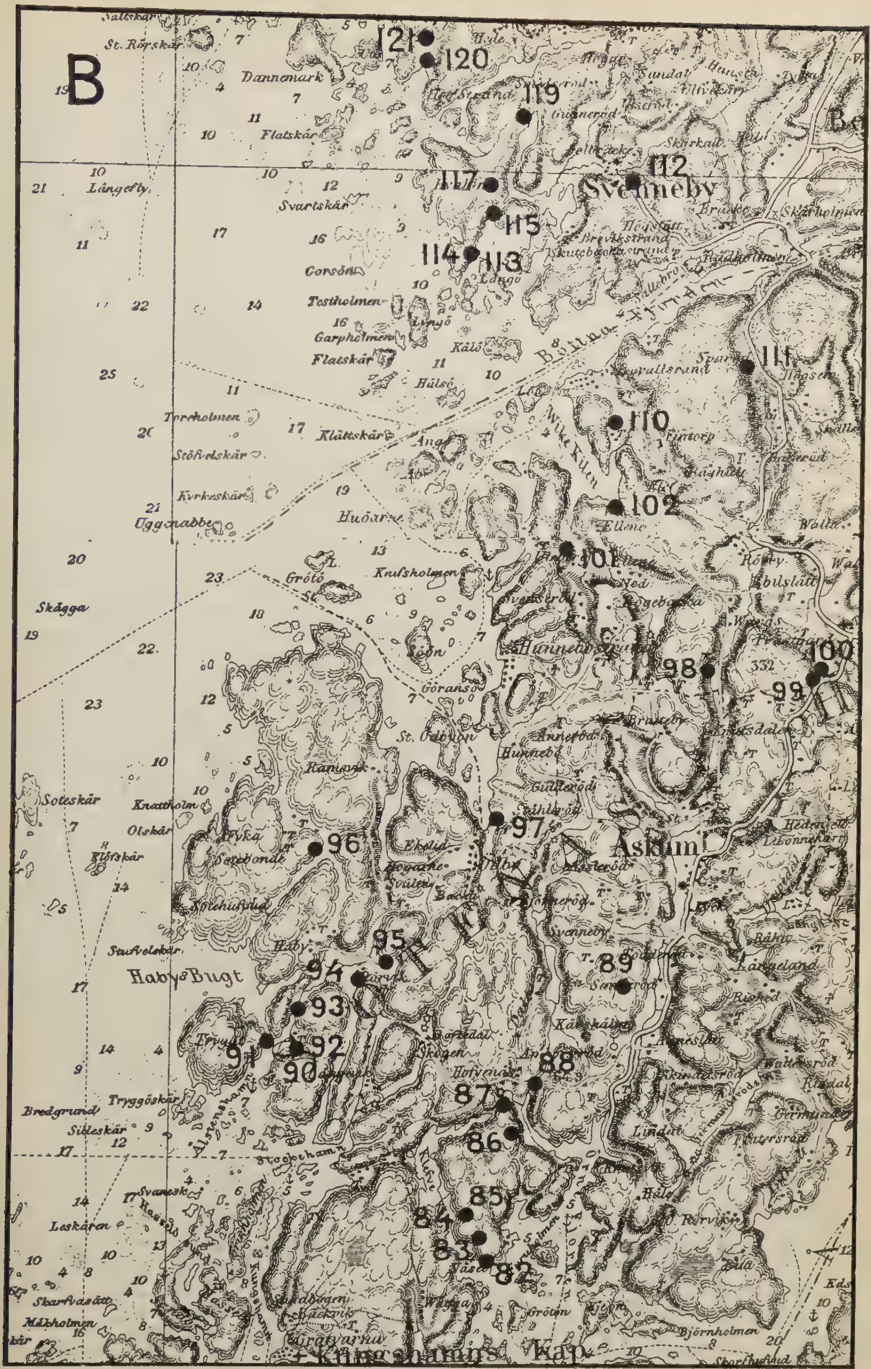

Fig. 5. Position of the shell beds examined in the region Gravarne—Bovallstrand (beds 82—121). Scale 1 : 10,0000.

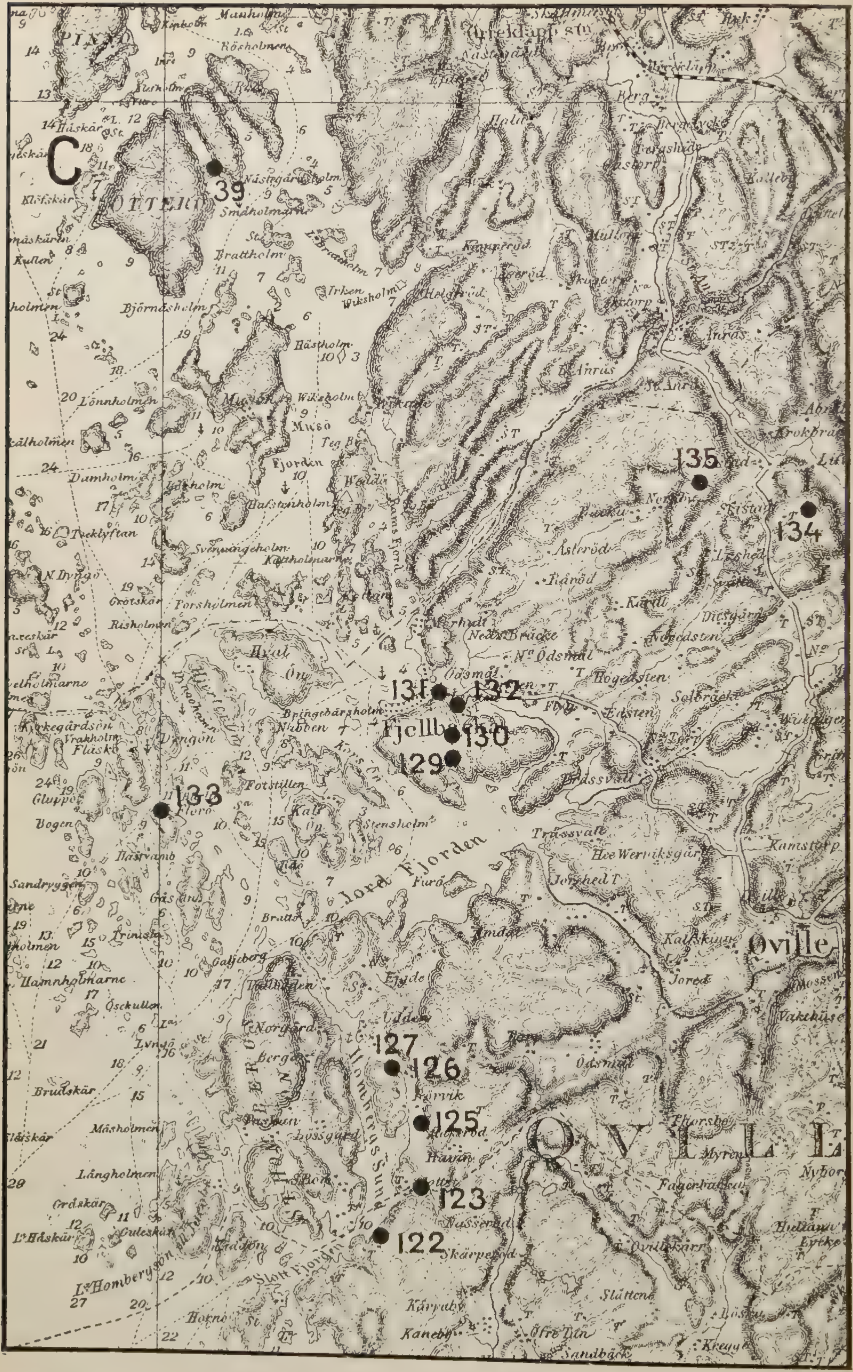

Fig. 6. Position of the shell beds examined in the region of Fjällbacka (beds 39, 122—127, 129—135). Scale 1 : 100,000.

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Addenda.

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Revue annuelle de la littérature suédoise sur la géologie quaternaire, 1927.

Pour faire la littérature suédoise sur la géologie quaternaire plus accessible la Société géologique de Stockholm (Geologiska Föreningen i Stockholm) a décidé de publier une revue annuelle de résumés en allemand, en anglais ou en français de cette littérature. Cette revue est censée être introduite annuellement dans le IV^e numéro de Geologiska Föreningens i Stockholm Förhandlingar. On commence par la revue suivante de l'an 1927. Le principe pour la rédaction des résumés est celui-ci: des travails publiés en des langues internationales et des œuvres avec des résumés détaillés dans une telle langue sont traités très sommairement, tant que des œuvres d'intérêt aussi pour des géologues non scandinaves et qui sont publiés dans la langue suédoise seulement, sont résumés plus en détail.

On peut aussi obtenir les revues annuelles séparément à un prix, qui dépend du volume de la publication chez Geologiska Föreningen i Stockholm, Stockholm 50, Suède.

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Géologie régionale.

HÖGBOM, A. G., Sveriges jord och grund. (The earth and ground of Sweden.) 230 pp. Lindblads förlag, Uppsala, 1927.

In this book Professor A. G. HÖGBOM gives a popular account of the geology of Sweden, especially accentuating the physiographic side of the subject. Pleistocene and recent features, so important in Swedish Geology, are given due attention and are looked upon from different points of view. The documents and main facts of the geological history of the country are described. One chapter deals with some types of nature: glacial and glacifluvial formations, deltas and sedimentary plains, peat bogs, dunes, lakes, etc. A subdivision of the country into great physiographic regions is suggested: 1) The region of marine clays and river sediments. 2) The south Swedish inland region. 3) The north Swedish region of forested till slopes and bogs. 4) The high mountains. 5) The silurian district of Jämtland. *N. G. Hörner.*

JESSEN, KNUD, Det förhistoriska Europas naturförhållanden. (Die Naturverhältnisse des vorgeschichtlichen Europas.) 57 S. 18 Textfig. (Aus: De förhistoriska tiderna i Europa I, Stockholm 1927).

Diese Arbeit bildet den ersten Abschnitt eines grösseren Werkes: »Die vorgeschichtlichen Zeiten in Europa». Verf. hat durch eine kritische Zusammenstellung vorliegender Untersuchungen eine Übersicht der quartären Geschichte Europas zu geben gesucht, um das Milieu, worin die älteste menschliche Kultur sich entwickelte, zu verstehen, wie auch auf geologischem Grund die Reihenfolge zwischen den ältesten Kulturepochen festzustellen. Die hauptsächliche Aufgabe ist, die verschiedenen Eiszeiten und Zwischeneiszeiten in Nordeuropa und in den Alpen zu parallelisieren. Deswegen behandelt Verf. in verschiedenen Kapiteln die Alpen während der Diluvialzeit und das nordeuropäische Glaziationsgebiet, wie auch die Naturverhältnisse und Ablagerungen in West- und Mitteleuropa, welche die Klimaveränderungen in irgend einer Art registrieren. Die verschiedenen Perioden in der Entwickelung der Diluvialzeit Europas werden in einem grossen Schema zusammengestellt.

In dem letzten Kapitel: »Europa in spätglazialer und postglazialer Zeit» beleuchtet Verf. durch viele Beispiele die Verbindung, die einerseits zwischen Niveauveränderungen und Klima, anderseits zwischen Archäologie und Besiedelungsgeschichte existiert. Auch die Entwickelung der spät- und postglazialen Zeit hat Verf. durch ein Schema übersichtlich gemacht.

Lennart Henning.

MUNTHE, HENR., HEDE, J. ERNHOLD och LUNDQVIST, G., Beskrivning till kartbladet Klintehamn. (Beschreibung zum Kartenblatte Klintehamn.) Sv. Geol. Unders. Ser. Aa. N:o 160. S. 1—109. Stockholm 1927.

Der Text schliesst sich den vorher gedruckten geologischen Karten von Gotland an. Er ist ganz summarisch, da er hauptsächlich aus dem Blattgebiet Beispiele über Verhältnisse, die schon in »Gotlands geologi» (Sv. Geol. Unders. Ser. C. N:o 331) beschrieben sind, zu liefern beabsichtigt. Die allgemeinen Züge werden in Kapiteln behandelt, betitelt »Glaziale Erscheinungen» (z. B. Schrammen), »Moränenbildungen», »Ablagerungen der Gletscherflüsse», »Erscheinungen der Gletscherflüsse» (Riesentöpfe) und »Täler», die von MUNTHE 1913 in Sv. Geol. Unders. Ser. C. N:o 249 beschrieben sind. Die westlichen Teile des Blattgebietes gehören dem jüngeren Transgressionsgebiet des Baltikums an. Diese Ablagerungen und die im Baltischen Eissee sind in den Kapiteln »Spätquartäre Ablagerungen des Baltikums» und »Erscheinungen von den Wellen des Baltikums ausgebildet» (Klinten, Höhlen und »Raukar») behandelt. Die übrigen quartärgeologischen Kapitel sind »Suprabaltische Ablagerungen des Festbodens» (Verwitterungsschotter, Schwemmbildungen und Flugsand), »Vertebratenfunde» und »Moore» (mit 3 Linienprofilen und 7 Pollendiagrammen). *G Lundqvist.*

MUNTHE, H., HEDE, J. E., och VON POST, L., Beskrivning till kartbladet Hemse. (Beschreibung zum Kartenblatte Hemse.) Sv. Geol. Unders. Ser. Aa. N:o 164, 155 S., 93 Fig., 2 Karten, Stockholm 1927.

Das geologische Blatt »Hemse» umfasst den südwestlichen Teil der Insel Gotland mit den beiden Inseln Stora Karlsö und Lilla Karlsö.

In bezug auf quartärgeologische Erscheinungen seien zunächst die glazialen erwähnt. Die Spuren der Erosionstätigkeit des Eises sind besonders im nordöstlichen Teil des Kartenbereiches auffallend, wo die widerstandsfähigen silurischen Riffkalkbildungen als Höhen erscheinen, weil die sie umgebenden Schichten entfernt worden sind.

Auf dem Blatt treten ferner die spät- und postglazialen Ablagerungen deutlich hervor. Hauptsächlich im Norden erscheinen die Kies- und Sanddecken des Baltischen Eissees, die sich, teilweise als Uferwälle ausgebildet, bis auf den höchsten Punkt Gotlands (82.8 m. ü. d. M.) erstrecken. Von SO aus gegen NW hin kann man den gewöhnlich aus Geröll gebildeten Ancylusgrenzwall verfolgen, der in der erwähnten Richtung von 23 bis 29 m ü. d. M. steigt. Die übrigen Ancylusablagerungen, aus Kies und Sand bestehend, sind grösstenteils oberhalb des Litorinagrenzwalles verbreitet, sind indessen auch unterhalb desselben angetroffen worden. Der letzterwähnte Grenzwall läuft parallel dem Ancyluswall, in gleichartiger Weise ausgebildet, aber in einer Höhe von im SO 15, im NW 18 m ü. d. M. Die Litorinaablagerungen, überwiegend Kies und Sand, überlagern an mehreren Stellen supramarine Bildungen. MUNTHE erwähnt z. B. folgende Schichtenfolge:

A. Litorinasand, unten tonig, mit *Cardium*, *Tellina*, *Mytilus*, *Hydrobia* etc.
B. Torf mit Kiefer, Erle, Eiche etc.
C. Kalkmoor mit Schalen von Land- u. Süsswassermollusken
D. Ancylussand mit u. a. *Ancylus fluviatilis*
E. Moräne oder Fels.

Man hat auch Ancylusbildungen angetroffen, die suprabaltische Torfschichten überlagern.

Schliesslich kommen auf dem Blatt »Hemse» weitausgedehnte Torfmoore vor, von denen mehrere (von den erwähnten Uferwällen aufgestaut) aus einstmaligen Lagunen hervorgegangen sind. Die Entwicklungsgeschichte der Moore und der Vegetation des Gebietes ist von L. VON POST ausführlich behandelt. Von besonderem Interesse sind die Detailuntersuchungen über das Mästarmyr, das grösste Moor des Gebietes. *Eric Laurell.*

VON POST, L., **Beskrivning till Översiktskarta över södra Sveriges myrmarker. (Beschreibung zur Übersichtskarte über die Moore Südschwedens.)** – Sv. Geol. Unders., Ser. Ba. N:o 11. Stockholm 1927.

Die Übersichtskarte über die Moore im südlichen Schweden ist eine Zusammenstellung der geologischen Detailkarten, die in Massstäben von 1:50 000 bis 1:200 000 herausgegeben sind. Die Karte führt die verschiedenen Moortypen unter einer gemeinsamen Bezeichnung und dazu die Schlammböden auf, und ist in zwei Blättern im Massstabe 1:500 000 veröffentlicht. Da die Beschreibung bald in einer englischen Übersetzung herausgegeben wird, genügt es, hier eine kurze Inhaltsübersicht zu geben. Verf. beginnt mit einer Übersicht über die Entstehung und den Zweck der Karte. Dann folgt eine Analyse der regionalen Verteilung der Moore und eine Auseinandersetzung, inwiefern der Begriff Moor auf der Karte dem wirklichen Verhältnis entspricht. In dem folgenden Kapitel werden einige geomorphologische Züge behandelt. Zum Schluss diskutiert Verf. die Frage, ob die Versumpfung in der Gegenwart fortdauert, und findet, dass man diese Frage betreffs des südlichen Schwedens verneinen muss. Die Arbeit ist von vielen instruktiven Karten begleitet. *E. Granlund.*

Sandegren, R., Beskrivning till kartbladet Lurö. (Beschreibung zum Kartenblatte Lurö.) — Sv. Geol. Unders. Ser. Aa, N:o 166, 43 S., 2 Karten, 16 Textfig., Stockholm 1927.

Das Kartengebiet umfasst den nördlichen Teil von Kållandsö nebst den Inselgruppen von Lurö und Djurö im See Vänern. Das Gebiet besteht grossenteils aus Schären mit nackten Felsen, und die quartären Ablagerungen sind relativ unbedeutend.

Zuerst wird über Glazialschrammen und Riesentöpfe berichtet. Ose und eigentliche Moränenablagerungen kommen nicht vor. Unter den losen Ablagerungen spielen Sand, Kies und Geröll, die von dem See Vänern in postglazialer Zeit umgelagert worden sind, die grösste Rolle. Weiter kommen postglazialer Vänerton und Torfbildungen vor. Zwei Pollendiagramme illustrieren die postglaziale Entwicklungsgeschichte der Wälder des Gebietes. *R. Sandegren.*

Géologie générale et dynamique.

Andersen, S. A., Storebaelt i Nutid og Fortid. (Grosser Belt in Gegenwart und Vorzeit.) G. F. F. Bd. 49, S. 427—437.

Die submarine Morphologie des Grossen Belt bietet ein interessantes Problem in den tiefen Rinnen und Gruben am Boden, welche nicht nur längs der Hauptrinne des Sundes vorkommen, sondern auch an deren Seiten als Neben- oder Parallelrinnen. Verf. gibt eine eingehende Beschreibung der Lage dieser Vertiefungen und findet, dass sie da vorkommen, wo die Passage am engsten ist. Dies Verhalten deutet an, dass die Vertiefungen ihre Ausbildung der Erosion durch Meeresströmungen im Belt verdanken, und zwar nach dem Abschmelzen des Eises und zum grossen Teil in postglazialer Zeit während hydrographischer Verhältnisse, die nicht wesentlich von den gegenwärtigen abwichen. Verf. gibt einen Überblick über die jetzigen Wasserströmungen des Beltes. Der eingehende Bodenstrom von 30 ‰ Salzgehalt, welcher unterhalb des süssen Ostseestroms gegen Süden strömt, hat eine bedeutende Geschwindigkeit; während diese in 20 m Tiefe im nördlichen Belt gelegentlich bis auf 50 oder sogar 80 cm/sek. steigen kann, hat der Strom in der Tiefenrinne des südlichen Belts eine Geschwindigkeit von 5—6 km in der Stunde, d. h. mehr als 150 cm/sek. Da der Boden hier aus tertiären Tonarten besteht, welche an mehreren Orten von Sand bedeckt sind, vermag ein so kräftiger Strom den Boden zu erodieren und das lose Material wegzuschaffen.

Diese Auseinandersetzung ergibt, dass die Tiefe der Aushöhlungen nicht als Mass einer früheren Höhenlage des Landes anzunehmen ist, und dass diese Vertiefungen Neubildungen sind, die in der präformierten Tektonik nach dem Ertrinken der eventuellen Flussrinne entstanden. Einige topographische

Züge sprechen dafür, dass diese Rinne präquartär angelegt wurde; das Schmelzwasser des Eises kann sie nicht angelegt haben, ist aber der Rinne gefolgt und hat sie stellenweise geprägt.

Dass Meeresströmungen eine erodierende Kraft besitzen können, dafür sind die von A. JESSEN beschriebenen und auf die durch Ebbe und Flut hervorgerufenen Strömungen zurückgeführten Vertiefungen zwischen den westschleswigschen Inseln (z. B. die 35 m tiefe bei Sild) ein Beweis. ANDERSENS Theorie gibt daher eine befriedigende Erklärung der fraglichen Erscheinungen, wie z. B. auch ähnlicher Vertiefungen (bis zu 124 m Tiefe) in der Tiefenrinne des Kattegat, wo schwedische Expeditionen eine Geschwindigkeit des Bodenstromes von 61 cm/sek. gemessen haben. *N. Hj. Odhner.*

EXNER, FELIX M., Über Dünen und Sandwellen. Geografiska Annaler Bd. IX, 1927, pp. 81—99.

Starting from observations on shape and structure of eolian and aquatic sand deposits of the great Courland bar on the southeast shore of the Baltic, the author gives a physical explanation of the formation of sand waves.

Perpendicular to the wind direction were formed not only small ripples and large dunes, but also ridges of several intermediate sizes, all resembling waves. Sub-aquous ripples are of the same type.

Because of the load of picked-up grains the lowest layers of the air or the water streaming over sand are heavier than higher layers. Waves are formed as between liquids of different density, although there is no clean cut contact but a gradual transition between, say, air loaded with sand and air free from sand.

EXNER expresses mathematically the relations between the density of the air or water with its load of sand, the velocity of the wind or current, and the dimensions of the waves. The theory seems to correspond to empirical values except for large dunes.

Among other forms discussed are wave shaped shore lines.

N. G. Hörner.

FRÖDIN, JOHN, Glaciala former i Pyrenéerna. (Études sur les formes glaciales dans les Pyrénées.) Svensk Geografisk Årsbok, 1927. p. 124—156 et Medd. fr. Lunds Univ. Geogr. Inst., Ser. C. N:o 26.

L'auteur décrit dans ce mémoire les formes de paysage qui dérivent de la période glaciaire. Parmi les formes principales on remarque les grands cirques, terminant des vallées de sac ou des vallées aveugles avec un profil transversal en forme d'une auge ou d'un U. En aval de la limite de la glaciation quaternaire le profil des vallées présente la forme d'un V. — L'extension des moraines frontales et latérales est très différente sur les deux versants de la montagne. — Dans les montagnes qui ont subi une glaciation plus étendue qu'aujourd'hui les lacs sont un des traits les plus caractéristiques. On peut en distinguer trois types: 1) les lacs de piedmont, 2) les lacs de vallées et 3) les lacs de haute montagne. Actuellement, dans les Pyrénées les lacs des types 1) et 2) ont disparu et seulement les lacs du type 3) ont resté. Cependant il en est autrement dans des autres montagnes qui ont été occupées par une glaciation étendue. *Karl A. Grönwall.*

(D'après le résumé de l'auteur.)

Hansson, Folke, Några iakttagelser rörande marsken vid Arlöv. (Einige Beobachtungen über die Marsch bei Arlöv.) G. F. F. Bd 49, 1927, S. 441—449, 5 Textfig.

Längs der Westküste Schonens erstreckt sich ein Marschland als ein Streifen von Wiesengrund, der durch eine Masse unregelmässig vorkommender Höhlungen und Rinnen gekennzeichnet ist. Diese Unebenheiten sind durch die Erosion des Wassers verursacht. Diese ist in Schweden nicht so kräftig wie an den Küsten, wo Ebbe und Flut vorkommen. Die Überspülung geschieht nämlich hier nur durch Sturmfluten und andere zufällige Erhöhungen des Wasserstandes. Das Marschland ist eine Sandmarsch, die allmählich abgebaut wird. Der Uferrand ist zerstückt, was in verschiedener Beschaffenheit des Bodens seine Ursache hat. Durch die Wellenschläge gegen das Ufer hat dieses einen steilen, beinahe senkrechten Rand gegen das Meer erhalten. Die Marsch besteht aus einem Humuslager über lehmhaltigem Sand und darunter marinem Schwemmsand. Der Gehalt an Sand nimmt in der Schichtenreihe aufwärts ab und der Gehalt an Humus nimmt aufwärts zu. Die Sandkörner bestehen grösstenteils aus Quarz, aber auch Körner von Feldspat, Hornblende und Feuerstein kommen vor. Von Diatomeen werden vornehmlich *Diploneis interrupta*, *Synedra filiformis* und *Synedra tabulata* angetroffen und von Tieren *Arenicola marina*, *Mytilus edulis*, *Cardium edule* und *Litorina litorea*. In Schweden wird die Marsch fast ausschliesslich als Weide gebraucht, an gewissen Orten aber auch als Ackerboden. *Folke Hansson.*

von Post, Lennart, Jordskred och orogenes. (Erdrutsche und Orogenese.) Geol. För. Förh. Bd. 49, 1927, 26 S. 16 Fig.

Verschiedene Forscher haben Gebirgsbildung durch orogenetische Modelle zur Veranschaulichung zu bringen versucht. Bei diesen sämtlichen Modellen muss indessen eine bestimmte Kraftanordnung angenommen werden, was in wesentlichem Grade den Wert der Resultate verringert.

Verf. hat bei der Studie über gewisse Erdrutsche, die in den schwedischen Tonebenen vorkommen, gefunden, dass die Ausgangsbedingungen und der dynamische Verlauf bei denselben wie die Massendeformierungen, die dabei entstehen, auf eine gewisse Analogie mit den gebirgsbildenden Massenverschiebungen deuten. Verf. meint deshalb, dass eine planmässige Ausnutzung der Bodenverschiebungen der Tongelände als orogenetische Modelle den Modellversuchen der Laboratorien vorzuziehen wäre.

Besonders günstig ist das Verhältnis, dass die Tonrutsche durch Verrükkungen des statischen Gleichgewichtes entstehen, und dass sie in ihrem Bewegungsverlauf den Gesetzen der Isostasie folgen.

Durch instruktive Profile und Photographien zeigt Verf., wie man beispielsweise den appalachischen Faltungstypus, treppenförmige Verwerfungen, Bruchlinienlandschaften von dem Typus, den das mittlere Schweden bildet, u. s. w. in denjenigen Deformierungsbildungen wiederfinden kann, die bei grösseren Bodenverschiebungen in Tongeländen entstanden sind. Bei Tonrutschen vorkommende innere Deformierungen, Überschiebungen u. s. w., markieren noch die herrschenden Analogien zwischen Orogenese und Tonrutschen.

Verf. betont, dass bei grösseren Tonrutschen eine distale Erhebung häufig ist, und hebt schliesslich hervor, dass einige charakteristische Züge mehrerer

Gebirgsketten leicht ihre Erklärung erhalten würden, wenn man annähme, dass diese Gebirgsketten gehobene Distalpartien isostatischer Verschiebungen wären. *Alf Lundegren.*

Géochronologie.

ANTEVS, ERNST, Sista istäckets försvinnande i Nordamerika. (Das Verschwinden der letzten Eisdecke in Nordamerika.) Ymer, Jahrg. 46, 1926, S. 283—297, 2 Textfig.

Verf. hat umfassende Messungen von Bändertonen nach der Methode von G. DE GEER in den östlichen Teilen der Vereinigten Staaten und Canada ausgeführt und gibt in dieser Arbeit eine Zusammenfassung der Resultate seiner Untersuchungen. Die Hauptzüge der Rezession des Inlandeises in Nordamerika werden hier klargelegt. Ausführlichere Darstellungen hat Verf. in drei Arbeiten in englischer Sprache publiziert, nämlich: »The recession of the last ice sheet in New England» (Amer. Geog. Soc. Research Ser. No. 11, New York 1922), »Retreat of the ice sheet in eastern Canada» (Geol. Survey, Canada Mem. 146, 1925) und »The last glaciation» (Amer. Geog. Soc. Research Ser. No. 17, New York 1928).

Betreffs des Verhältnisses zwischen der Eisrezession in Nordamerika und in Europa hebt Verf. hervor, dass die grösseren Klimaschwankungen wahrscheinlich synchron sind, und dass die Inlandeise der beiden Kontinente gleichzeitig verschwunden sind. In der jährlichen Abschmelzung und Absetzung von Bändertonen kann man aber nicht [wie G. DE GEER meint (»On the Solar Curve» etc., Geografiska Annaler, Stockholm 1926)] Übereinstimmung erwarten. Verf. sagt: »Gleichheit zwischen Warwendiagrammen bildet an und für sich keinen Beweis für Gleichzeitigkeit, da die Variationen der Kurven ziemlich beschränkt sind, und die Übereinstimmung auf Wiederholung von Perioden beruhen kann. Warwenkonnexionen sind stichhaltig nur, wenn sie auf Kurven mit guter und andauernder Übereinstimmung basiert sind, und wenn sie auf Messungen in solchen Gebieten gegründet sind, die in klimatischer Hinsicht in spätglazialer Zeit ähnlich waren, und betreffs welcher man annehmen kann, dass sie gleichzeitig eisfrei geworden sind.» *R. Sandegren.*

ANTEVS, ERNST, Trädtillväxt och klimat i historisk tid. (Baumzuwachs und Klima in historischer Zeit.) Ymer, Jahrg. 47, 1927. S. 321—336, 2 Textfig.

Verf. hat eine Revision des von E. HUNTINGTON eingesammelten *Sequoia*-Materials ausgeführt und gibt in dieser Arbeit eine Zusammenfassung der Untersuchungen über die Jahresringe der Bäume und ihre Benutzung als Zeugen von Klimaschwankungen. Die verschiedenen Faktoren, die auf den Zuwachs Einfluss haben, werden diskutiert, und die Korrektionsmethoden der Jahresringkurven werden beschrieben. Zuletzt werden die Resultate der *Sequoia*-Kurven für das Klima der letzten 3,000 Jahre dargelegt.

Verf. hat früher in drei Arbeiten in deutscher resp. englischer Sprache diese sehr interessanten Fragen behandelt. Vgl. »Die Jahresringe der Holzgewächse und die Bedeutung derselben als klimatischer Indikator» (Progr. Rei Bot. Vol. 5, 1917), »The big tree as a climatic measure» (Carnegie Inst.

of Washington, Publ. 352, 1925), »The climatologic significance of annual rings in fossil woods» (Amer. Journ. Sci. Vol. 9, 1925). *R. Sandegren.*

Berg, Åke, Möjligheterna för en absolut postglacial kronologi. (Die Möglichkeiten einer absoluten postglazialen Chronologie.) Fornvännen, 1927, S. 137—142. Zusammenfassung in deutscher Sprache S. 142.

Die Waldbäume Schwedens bilden jährliche Zuwachsringe, durch den dichteren und dunkleren Spätsommerzuwachs angedeutet, welcher von dem Zuwachs des nächsten Jahres durch eine scharf markierte Linie abgegrenzt wird. Man meint, dass dies eine Anpassung an den Wechsel der Jahreszeiten bedeute und ziemlich weit in die Erdgeschichte zurückzuführen sei.

Der Zuwachs verschiedener Bäume zeigt unabhängig von Alter und Standort die deutlichsten Übereinstimmungen. Eine Figur zeigt die Mittelkurve für den Zuwachs von 10 Bäumen in Norrbotten während einer Periode von 30 Jahren mit ausgeprägten Maxima und Minima, die höhere oder niedrigere Temperatur andeuten. Wenn die Mittelkurve von einer bestimmten Lokalität bekannt ist, muss man ein Holzstück datieren können, das mit einer genügenden Anzahl von Jahresringen·versehen ist. Wenn die Zuwachskurven von lebenden Bäumen mit solchen von den subfossilen Baumstämmen in den obersten Schichten der Torfmoore kombiniert werden können, scheint es möglich, durch die in den tieferen Schichten eingebetteten Stämme eine feste Chronologie auch für noch entferntere Zeiten zu erhalten. Verf. hat angefangen, solche Bestimmungen zu machen.

(Nach Fornvännen 1927.) *R. Sandegren.*

De Geer, G., Late glacial clay varves in Argentina measured by Dr Carl Caldenius, dated and connected with the Solar curve through the Swedish Timescale. Data 10 fr. Stockholms Högskolas Geokronol. Inst.! — Geografiska Annaler, Stockholm, Bd 9, 1927, H. 1—2, pp. 1—8, Pl. 1, varve diagrams.

The teleconnection with North America being achieved and that with Himalaya going on the author made a proposal to the director of the Geological Survey of Argentina, Dr José Sobral, concerning the extension of the geochronological investigations also to his country and thus to the southern hemisphere. Dr Sobral appreciated at once the plan and has all since shown the greatest interest in the whole undertaking.

By his arrangement Dr Caldenius from Stockholm, one of the author's most experienced varve experts, was engaged for the purpose said at the named Survey and has got excellent opportunities during several expeditions within the glaciated area of Patagonia to perform his investigations.

Thereby he observed at several places a row of very marked double morainic ridges, supposed to correspond to the middle-Swedish moraines. At the proximal side of the inner one he found at Lago Epuyén, and at Lago Corintos excellent varve series.

At the latter locality he measured a varve section 90 m high with about 560 annual varves. On the wish of Dr Sobral diagrams representing this series were sent to the author and by him connected with the Swedish time scale, as in detail described in this paper.

It turned out that the moraines, here called the Final moraines, really corresponded with analogous moraines in Sweden, N. America and Himalaya but that one and the same ice oscillation reaches the very ice-border somewhat earlier where the distance from the névé is shorter. Notwithstanding the distance of 14,000 km between Sweden and Argentina the similarity of the varve curves was very striking; and no less than 80 % of all the measured varves fitted in with the time scale. This shows that the melting variation of the ice embraced one north- and one south summer i. e. one termal year probably commencing at one or another of the equinoxes. As to other conclusions it may be referred to the paper itself. *G. De Geer.*

De Geer, G., Schwankungen der Sonnenstrahlung seit 18000 Jahren. Aus dem Englischen übersetzt von G. Steinmann, Bonn, und vom Verf. durchgesehen. — Geol. Rundschau, Berlin, Bd 18, 1927, H. 6, pp. 417—454. Eine Tafel mit Warwendiagrammen und eine mit Korrelationskarten.

This paper contains, after a short introduction, a close translation of two different papers. The first one of these is:

On the Solar curve as dating the Ice Age, the New York moraine and Niagara Falls through the Swedish Timescale. Data, 9, fr. Stockholms Högskolas Geokronol. Inst. — Geografiska Annaler, Stockholm, Bd 8, 1926, H. 4, pp. 253 –284, Pls 1—2, varve diagrams, Pl. 3, maps of correlation.

Introduction. The Swedish Timescale. Subdivision of the timescale. Teleconnection or time-correlation at great distances. The first transatlantic teleconnections. Connection of the Gotiglacial, or Baltic, and the New York Moraines. (Pl. 1 and 2.) Connection between the Swedish Timescale at the commencement of the Finiglacial subepoch and the synchronous Toronto-Niagara stage, marking the birth of Niagara Canyon; the finiglacial ice-oscillation in Sweden and North America; the Ontario ice-lobe and the dating of Niagara Falls; former estimates of its age. Connection of the Swedish Timescale at the end of the Ice Age proper with corresponding varve series in Canada north of Lake Timiskaming. Summary: the solar curve as registering the sun radiation; aims of the Geochronology. Acknowledgements. Authors quoted. Appendix: notes to the diagrams; remarks to the map.

The other paper was: Data, 10, reviewed above.

In the translation the diagrams are given in one fifth of the original scale. *G. De Geer.*

De Geer, G., Geochronology as based on solar radiation. Science Vol. 66, No 1715 New York 1927, Nov. 11, pp. 458—460.

A short summary of the evolution of geochronology. The bottom-varves were deposited immediately after the recession of the iceborder und thus dating the last one. In this way the ice-recession in Sweden is determined at more than 1,500 localities. But, with exception for Finland, elsewhere the bottom-varves are seldom reached, thus along the Connecticut valley according to the very valuable report of dr Antevs only at half a dozen localities. Though the changes in the ice recession in this valley thus can not yet be determined and though it was not possible even to dr Antevs himself to follow up a continuous varve-series all the way from U. S. A. to Canada, this happily enough did not matter because the gaps could be reliably overbridged by means of just the doubted but in reality quite conclusive teleconnections with the Swedish time scale. Thereby it is also shown how misleading it can be to use uncertain estimates for filling out such gaps.

Almost all of the varve series measured by the Swedish North-America expedition of 1920 had been correlated with the Swedish time-scale and this was also the case with different varve series measured by E. NORIN in Himalaya and C. CALDENIUS in Argentina. Considering the continually growing length of characteristic varve variations it seems beyond every doubt that only real identity can explain such a considerable sum of similarities.

Among other conclusions now possible or already reached is mentioned the existence of an annual and a biennial periodicity in the varve curves and the probable existence of a thermal year not coincident with the fiscal one.

Still before certain local deviations from the true solar curve are eliminated it is not advisable to transcribe the varve thicknesses in figures intended for smoothing calculations. *G. De Geer.*

DE GEER, G., The tracks of the sun, a short tale of a long time. The Forum, Vol. 78, No. 6, New York 1927, pp. 858—863. — Also published in Swedish: Om solens spår, en kort sannsaga om långa tidsåldrar. Nordisk Tidskrift. Årg. 3, Stockholm 1927, H. 5, p. 341—347.

A short popular summary of the origin, evolution and aims of the newfounded geochronology as based on varves or annual clay layers deposited from glacial melting waters and registering annually since nearly 18,000 years the variations in the solar heat which is thought to be the only possible cause of the whole phenomenon. In the English edition is given a graph of the Swedish time scale, showing the relation of the main historical stages to those of the natural time scale. *G. De Geer.*

DE GEER, G., Om snön som föll i fjol. (The snows of last year.) In the journal: Ord och Bild, Årg. 36, Stockholm 1927, p. 210—212.

The Swedish proverb »don't speak of the snows of last year» takes for granted this being of no consequence. Still once it was just the accumulation of snow from year to year that caused the whole of the Ice age.

The present note contains a popular summary of the old struggle between the sun and the snow showing why we have good reason to study its fluctuations and not to take this proverb too literally. *G. De Geer.*

MILTHERS, V., On the so-called Gothi-glacial limit in Denmark. (Über die sogenannte Gothiglaziale Grenze in Dänemark.) Geografiska annaler, Stockholm, Jahrg. IX, 1927, S. 162—172, 2 Textfig.

Verf. richtet eine Kritik gegen den Aufsatz von G. DE GEER »On the solar Curve as Dating the ice Age, the New York Moraine, and Niagara Falls through the Swedish Time-Scale» (Geografiska Annaler, Jahrg. VIII, Heft 4,

1926). DE GEER hat in dieser Arbeit Dänemark als Glied in der Fernkonnexion zwischen Schweden und Nordamerika benutzt.

MILTHERS macht hier darauf aufmerksam, dass die Altersverhältnisse, die DE GEER (durch Messungen von Bändertonen) zwischen verschiedenen dänischen Lokalitäten einesteils und zwischen diesen und Lokalitäten in Schonen anderenteils angibt, gar nicht mit dem relativen Alter stimmt, das diesen Ablagerungen gemäss den Endmoränenlinien zukommt. DE GEER hat auf seiner Karte Eisrandlinien gezeichnet, die quer über die von den dänischen Geologen kartierten Endmoränenlinien verlaufen. Somit sind Ablagerungen, die ihrer Lage nach im Verhältnis zum Eisrande zu den ältesten gerechnet werden müssen, den Warwenmessungen nach unter die jüngsten verwiesen worden und vice versa. Auch sind Ablagerungen, die regional miteinander eng verbunden sind, den Warwenmessungen nach durch eine Periode von 3,000 Jahren voneinander getrennt worden.

Der dänische Teil der DE GEERschen Zeitskala eignet sich darum nicht zum Glied in der Fernkonnexion zwischen Europa und Amerika. Verf. sagt: »Die Methode von DE GEER hat wie andere Methoden ihre Fehlermöglichkeiten. Erst wenn man innerhalb eines beschränkten Gebietes Übereinstimmung gewinnen kann zwischen den verschiedenen Elementen, die in Betracht kommen müssen, nämlich Landschaft, Warwen und übrigen stratigraphischen Verhältnissen, wird es vielleicht möglich sein, auch eine Grundlage für Vergleichungen zwischen so weit voneinander getrennten Gebieten wie Scanodania und Nordamerika zu erhalten.» *R. Sandegren.*

NORIN, E., Late glacial clay varves in Himalaya connected with the Swedish time-scale. Data, 11. Fr. Stockholms Högskolas Geokronol. Inst. Geografiska Annaler, Stockholm, Bd. 9, 1927, H. 3, pp. 157—161. Pl. 2. Varve diagrams.

In a paper: Preliminary Notes on the late Quaternary glaciation of the North-western Himalaya, published as Data 2 in the same journal, the author presented the first correlation between varves in Himalaya and in Sweden. During a second expedition, 1925, the author succeeded in getting good control of his earlier connection by parallel measurements at a new locality, partly also filling out a gap in his former curve. The stratigraphy is illustrated by a section and accompanying description.

Varve sections were measured at several other localities and also from different horizons but this material is not yet worked out.

G. De Geer.

Dépôts glacifluviaux.

ANDERSSON, OSCAR, Bredåkra randdelta. Ett säreget blekingskt naturlandskap. (The marginal delta of Bredåkra. A remarkable natural landscape in the province of Blekinge.) Svensk Geografisk Årsbok, 1927, pp. 47—69 and Medd. fr. Lunds Univ. Geogr. Inst., Ser. C. N:o 23).

The marginal delta of Bredåkra in Blekinge is the best developed delta of the so called South Swedish ice-border-line. It measures in length about 10 km., 4 km. in width, the thickness being estimated to 10—15 m. in average. The rough underground of granite has influenced the recession of the

ice, to a high degree. The ice-margin seems to have lacked all independent and original power of motion, and was extensively broken up into »dead ice», the typical manner of the ice recession in many parts of Sweden. The retreat seems to have taken place in a more regular way to the west. The delta was deposited in the South Baltic ice-lake, and, of course, the border line of this lake does not correspond with the marine limit, f. i. in Halland. At the retreat of the land-ice probably the land slightly emerged, starting from south, although the details and course of this elevation are not clear enough. (From the author's abstract.) *Karl A. Grönwall.*

Hörner, N. G., Brattforsheden, ett värmländskt randdeltekomplex och dess dyner. (Brattforsheden, a complex of wash plains or marginal deltas and its dunes.) Sveriges geologiska undersökning, Ser. C, N:o 342 (årsbok 20 (1926) N:o 3) 208 pp. 2 plates (map and sections). English summary pp. 193—206. Stockholm 1927.

Brattforsheden, situated some 35 km. north of the northeastern corner of Lake Vänern, is a complex of sand and gravel deltas deposited by glacial rivers in the sea off the last receding ice sheet. The ice border here made a local halt due to topographical conditions at the mouth of a late-glacial fjord on the open sea. The morphology and interior structure of the deposits permit conclusions about different phases of their formation. Because of the upheaval of the land after the release from the ice the shore has receded, so that the old deltas and the contemporaneous shore-line — the highest marine limit — now lie far inland and 180 to 190 m above sea level.

Brattforsheden is partly occupied by sand dunes and loess formed after the withdrawal of the ice and now fixed and covered by vegetation. The wind-blown deposits are older than the peat bogs of the region, and these go back at least to a fairly early stage of the post-arctic warmth period. Dunes were cut by ravines soon after the modern level of 150 m rose above the sea, if not earlier, and judging from the probable rate of uplift of the land this may have occurred a few hundred years after the release from the ice.

The shape and structure of the dunes indicate that they were largely formed by northwesterly and westerly winds. The influence of the ice sheet on the winds at the time of the sand-drift seems to have been insignificant. A glacial anticyclone cannot have determined the wind directions in front of the receding land ice. Conditions in some other Swedish dune fields lead to similar conclusion. Also the old central European dunes, caused by predominantly westerly winds, most likely were formed in the belt with little or no vegetation in the vicinity of the ice border. The above views regarding the winds off the last ice sheet seem to be supported by the conditions in modern glaciated areas. *N. G. Hörner.*

Variations de niveau.

Asklund, B., Stenåldersfynden och Litorina-Tapesgränsen. (Die steinzeitlichen Funde und die Litorina-Tapes-Grenze.) G. F. F. Bd. 49, S. 112—132.

Neuerdings hat W. Ramsay in einer Arbeit »Niveauveränderungen und steinzeitliche Besiedelung im baltischen Gebiete» (Fennia 1926) eine aus-

gezeichnete Zusammenfassung des für das Problem der postglazialen Niveauveränderungen wichtigen Detailmaterials der Quartärgeologie und Archäologie gegeben. RAMSAY gibt hier eine umfassende Neubestimmung der Litorinagrenze in den nördlichen Teilen des baltischen Gebietes und macht darauf aufmerksam, dass die Litorinagrenze nahe mit den Meeresniveaus der Übergangszeit zwischen älterer und jüngerer nordischer Steinzeit zusammenfällt. Das Niveau der Litorinagrenze wird folglich durch naheliegende Funde der primitiven Schlagtechnik-Äxte (Scheibenspalter, Kernäxte, Lihult-, Limhamns-Äxte usw.) und der jüngeren Walzenbeile archäologisch charakterisiert.

Dieser Umstand, der zuerst durch die klassischen Untersuchungen W. C. BRÖGGERS ans Licht gestellt wurde, geht auch aus den neueren Untersuchungen der steinzeitlichen Besiedelung Finnlands hervor (A. EUROPÆUS).

Der Verfasser, der während der letzten Jahre im südlichen Norrland, Gästrikland, gearbeitet hat, sucht nach den erwähnten Gesichtspunkten durch Niveaubestimmungen der erwähnten steinzeitlichen Funde (nicht nur der äusserst spärlichen Wohnplatzfunde, sondern auch der in diesen nördlichen Gebieten noch ganz gewöhnlichen »losen» Funde der bezüglichen Steinäxte) das wahrscheinliche Niveau der Uferfläche, die mit der in südlicheren Gebieten markierten Litorinagrenze synchron ist, festzustellen. Rein geologisch genommen, findet man nämlich in den nördlichen Gegenden keine sicheren Strandbildungen des maximalen Standes des transgredierenden Litorinameeres, was bedeuten kann, dass hier die Transgression von kontinuierlicher Landhebung überwunden wurde.

Um die Lage der Litorinagrenze rein archäologisch bestimmen zu können, muss aber geprüft werden, ob es wirklich untere Grenzen der verschiedenen steinzeitlichen Funde, und spez. der Äxtefunde, gibt. Verf. liefert eine ausführliche Studie darüber, besonders betreffs der Gegenden, wo die Litorina- oder Tapes-Grenze rein geologisch bestimmt worden ist. Diese Prüfung zeigt, dass zwei Typen von Gebieten vorkommen. Erstens zeigen die mittleren Teile von Schweden eine auffallende Übereinstimmung mit den Resultaten W. C. BRÖGGERS: die Funde der älteren nordischen Steinzeit hören, vermischt mit Funden von Walzenbeilen, bei etwa 85—90 % der Litorina-Tapes-Grenze auf. Darunter gibt es ein Niveaugebiet, etwa 85—70 % (oder im Oslo-Gebiet etwa 60 %) der L.-T.-Grenze, das nur durch Walzenbeilfunde charakterisiert ist. Das heutige Material gibt demnach gute Beweise für die Richtigkeit der Ausscheidung einer »Walzenbeil-Zeit» (MONTELIUS) in den Gegenden von Oslo in Norwegen, nördl. Bohuslän, Östergötland, Närke, Uppland, Västmanland und südl. Dalekarlien in Schweden. Aber zweitens ergibt sich, dass in den ausserordentlich reichen Fundgegenden von südl. Bohuslän und Halland die Schlagtechnik-Äxte bis nach 70 % der Tapes-Grenze hinabgehen. Wenn man nicht diese auffallende Anomalie geologisch erklären kann, scheinen die ersteren Ergebnisse sehr unsicher oder sogar ganz zufällig. Durch eine eingehende statistisch-graphische Prüfung der Niveaus der älteren steinz. Funde von den Inseln Orust und Tjörn (nördl. von Gotenburg) gelingt es jedoch nachzuweisen, dass die niedrige Lage der mit Schlagtechnik-Äxten versehenen Wohnplätze wahrscheinlich mit der Tapes-Transgression zusammenhängt. In letzterer Zeit wurde nämlich für die Nachbargegenden von Gotenburg eine Tapestransgression von mindestens 9 Metern konstatiert (SANDEGREN). Es interessiert da aufs höchste zu wissen, ob die steinz. Besiedelung der schwed. Westküste schon vor der Transgression eingetroffen war. Die Fundbeschreibungen von A. Enquist über die steinz. Besiedelung Orusts und Tjörns geben bez. dieser Frage Antwort. Schon das Material jener Wohnplätze, die etwa 50 m über der heutigen Meeresfläche liegen, trägt Spuren der Wellenbearbeitung der Meeresbrandungen, weshalb es sicher ist, dass die Besiedelung der sog. Erteбölle-Stufe schon an den Ufern des 20 m über die Tapes-Grenze ragenden postglazialen Meeres florierte. Dieser Umstand, der von Ramsay betont wurde, führt die älteste Besiedelung dieser Gegenden wenigstens in die mittl. Ancylus-Zeit zurück. Damit ist es offenbar, dass die »epipaläolithische» Bevölkerung von der umfassenden Meeresschwankung oder Tapes-Transgression betroffen wurde, und man kann erwarten, dass ihre Geräte bis an das niedrigste Niveau des vor-litorinalen Meeres hinunterreichen. Folglich bezeichnen die untersten Funde des Ertebölle-Typus eine ältere Meeresfläche als das Tapes-Maximum. Sehr wichtig ist nun, dass die Walzenbeile zu der Zeit des Tapes-Maximums entstanden zu sein scheinen. Studiert man nun die Niveaus der Mischfunde von Schlagtechnik-Äxten und Walzenbeilen, so ergibt sich, dass sie bei etwa 85 % des Tapes-Maximums aufhören. Wohnplätze mit nur Walzenbeilen sind spärlich und hören bei 70 % des Tapes-Maximums auf.

Damit scheint es ganz sichergestellt, dass es synchrone Grenzen zwischen den Kulturstufen der Übergangszeit älterer und jüngerer nordischer Steinzeit gibt. Offenbar muss dann das Studium der Niveaus der besprochenen Fundtypen recht gute Hinweise geben, wo eine mit dem Litorina-Tapes-Maximum synchrone Strandfläche zu suchen ist. In den nördlicheren Teilen des Baltikums kann diese Methode grosses geologisches Interesse beanspruchen. *B. Asklund.*

Assarsson, G., Ancylus- och Litorinagränser inom geologiska kartbladet Gusum. (Ancylus- und Litorinagrenzen innerhalb des geologischen Kartenblattes Gusum.) — Sv. Geol. Unders. Ser. C. N:o 344. S. 1—29, 1 Karte, 16 Textfig. Stockholm 1927.

Auf dem Kartengebiet Gusum findet man an geeigneten Orten eine schöne Uferlinie, die ungefähr 70 Meter über dem Meere liegt. Diese Uferlinie, die die einzige besonders hervortretende in dieser Gegend ist, ist oft als Uferwall ausgebildet und ist als die höchste Grenze des Ancylussees aufgefasst worden. Systematische Untersuchungen der Torfmoore, die einige Meter unterhalb dieses Niveaus liegen, haben einige Lagerfolgen ans Licht gebracht, die eine Tonschicht zwischen zwei Schichten von lakustriner Gyttja zeigen und somit eine Transgression des Ancylussees andeuten.

Die Schichtenfolge ist von oben nach unten die folgende:

A. Torf.
B. Gyttja mit lakustrinen Diatomeen.
C. Ton (ein wenig Gyttja-haltig) mit einer Diatomeenflora, die (nebst lakustrinen Arten) bis zu 48 % aus den sog. Arenariaformen (Sundelin) besteht.
D. Gyttja mit bis zu 98 % lakustrinen Diatomeen.
E. Tongyttja.
F. Sand.
G. Bänderton.

Pollenanalysen von 4 solchen Lagerfolgen haben die Gleichzeitigkeit der Transgressionsschicht (C) gezeigt, und durch Vergleichung mit den früheren von L. von Post, U. Sundelin und H. Thomasson ausgeführten Untersuchungen[1] ergibt sich, dass diese Transgression gleichzeitig mit der Ancylustransgression auf Gotland und in der Kalmarer Gegend ist.

Die Uferlinie bei 70 Meter über dem Meere in der Gusumer Gegend repräsentiert also hier die Transgressionsgrenze des Ancylussees. Die Amplitude der Transgression ist, nach der Passhöhe der untersuchten Lokalitäten zu urteilen, grösser als 5.5 Meter, aber kleiner als 8 Meter gewesen.

Die höchste Grenze des Litorinameeres ist auf dem Gebiet des Kartenblattes Gusum durch keine deutlich hervortretende Uferlinie markiert, sondern ist durch das Aufsuchen des höchsten Niveaus der postglazialen Salz- und Brackwassersedimente, der sog. Clypeusgrenze (Sundelin), festgestellt worden. Die Clypeusgrenze liegt auf dem Kartenblatt Gusum irgendwo zwischen 41.5 und 36.5 Meter über dem Meere. Einige Lagerfolgen zeigen, dass die Transgression des Litorinameeres auch diese Gegend erreicht hat. Das Moor Sandtorpsmossen 36.5 Meter über dem Meere zeigt z. B. die folgende Schichtenfolge von oben nach unten:

A. Torf.
B. Gyttja, mit fast ausschliesslich lakustrinen Diatomeen.
C. Gyttja mit bis zu 80 % Brackwasserdiatomeen, ein paar % Arenariaformen und im übrigen lakustrinen Arten.
D. Tongyttja mit 35 % Arenariaformen und 65 % lakustrinen Arten.
E. Tongyttja (Ancyluston) mit 60 % Arenariaformen und 40 % lakustrinen Arten.

Durch Pollenanalyse wird gezeigt, dass die Litorinatransgression hier gleichzeitig mit derjenigen auf Gotland, nach den Untersuchungen von L. v. Post, und auf dem Kartenblatt Skrikerum, nach R. Sandegren, eintrifft. Die Amplitude der Transgression wird auf 6.5 Meter geschätzt.

G. Assarsson.

Granlund, Erik, Senglaciala strandlinjer och sediment i västra Bergslagen. (Les lignes de rivage et les sédiments de la fin de l'époque glaciaire dans l'ouest de Bergslagen.) Réf. d'un discours dans Geol. För. à Stockholm. Aussi imprimé à S. G. U. Ser. C. N:o 349. Sthlm 1928.

Le travail est un résumé des recherches au sujet des lignes de rivage de la mer de la fin de l'époque glaciaire et les phénomènes géologiques y appartenants, qui ont parvenu pendant le lever de la carte géologique de Filipstad. Voilà ce qui caractérise spécialement cette région:

A cause de l'élévation rapide du pays, la limite marine (l. m.) est très peu développée dans le terrain examiné. Presque toutes les déterminations de l. m. plus tôt publiées appartiennent à une autre ligne de rivage. Celle-ci se trouve dans l'est de Värmland c:a 10—20 mètres au-dessous de l. m. et se montre au contraire une limite stationnaire. Comme elle est synchrone le gradient de l'élévation du pays peut être calculé dans les 5 —6 m. sur mille.

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[1] L. von Post in: H. Munthe, J. E. Hede und L. von Post, Gotlands geologi. Sveriges Geol. Unders. Ser. C. N:o 331. U. Sundelin: Über die spatquartäre Geschichte d. Kustengegenden Östergötlands und Smålands, I, Bull. of the Geol. Inst. of Upsala XVI. 1919. H. Thomasson: Baltiska tidsbestämningar och baltisk tidsindelning vid Kalmarsund, Geol. Fören. Förh. Bd 49, 1927.

Parce que les sols de sédiment ne dépassent pas cette limite elle a été appelée la limite de la sédimentation (l. s.). Comme l. s., d'après les mesurages de l'argile rubannée, a été formée peu de temps après que la glace a quitté cette région, son influence sur le sol, qui était presque sans végétation, a été très grande et a entre autres formé des deltas autour des embouchures des ruisseaux. Les mesurages de l'argile rubannée montrent que la stagnation a duré au moins 300 ans. Cette longue période a causé une resédimentation des sédiments glacifluviaux en de très grands surfaces planes de deltas comme p. ex. Hållsjöfältet, Brattforsheden et Hälleforsfältet. Par la resédimentation l'assortiment a avancé et des terrains de sable mouvant ont pu provenir. *E. Granlund.*

Grönwall, Karl A., Till frågan om senglaciala och postglaciala nivåförändringar i södra Östersjöområdet. (Zur Frage der spätglazialen und postglazialen Niveauveränderungen im südlichen Ostseegebiete.) — Lund 1927. Schrift zur Doktorpromotion der philosophischen Fakultät der Karolinischen Universität zu Lund; auch »Meddelanden från Lunds Geologisk-Mineralogiska Institution», N:o 34.

Diese Arbeit beabsichtigt zunächst, einige Punkte der spät- und postglazialen Geschichte des Südbaltikums, die nach dem Erachten des Verf. nicht genügend berücksichtigt sind, näher hervorzuheben.

Die spätquartären Niveauoszillationen in Fennoskandia scheinen vom tektonischen Bau des Landes beeinflusst zu sein, was besonders in der südwestlichen Randzone, in Schonen, zum Ausdruck kommt.

In der spätglazialen Zeit war dort die Landhebung sehr unregelmässig mit sehr schwachen und wechselnden Gradienten der Isobasen im südlichen Schonen und sehr starken Gradienten im nordwestlichen. Bei der Diskussion der Niveauveränderungen muss man jedenfalls für Schonen die Möglichkeit eines Einflusses seitens des tektonischen Baues des Landes in Betracht ziehen.

Im südlichen Ostseegebiete scheint die Landhebung einen wellenförmigen Verlauf gehabt zu haben mit dem Maximum beim 55ten Breitegrade. Für die deutsche Küste scheint der grösste Betrag von Hebung, der sicher nachgewiesen worden ist, 20 m zu sein, obwohl auch grössere Beträge von verschiedenen Seiten verfochten werden; solche Hebungen kommen aber ebensowohl im Westen bei Lübeck wie im Osten im Weichseltale vor. Die grösste Senkung des Landes, die irgendwo im Ostseegebiete einwandfrei nachgewiesen worden ist, kommt südlich von Kåseberga in Südostschonen und südlich von Bornholm vor, wo von den Fischern beim Trawlziehen untermeerische Torfmoore in einer Tiefe von 35 m gefunden und grosse Stubben von Kiefern ans Land gebracht worden sind.

Für das Südbaltikum müssen wir da mit einem Mindestbetrag der Landhebung der Ancyluszeit und der Senkung der Litorinazeit von 35—40 m rechnen, was dann den Entwässerungen, wodurch die Oberfläche des Ancylussees auf das Niveau des Weltmeeres gebracht wurde, entsprechen sollte. Für die Entwässerung an der Schwelle des »Svea älv» muss man nach der Beschreibung von Post's einen Betrag von wenigstens za. 18 m veranschlagen, und die Tiefe der Darsser Schwelle bei der Kadetrinne beträgt za. 18 m. Alle diese Werte sind freilich Mindestwerte, das ist ja aber auch der Betrag der Senkung, der durch die submarinen Torfmoore angezeigt wird.

Bei dieser Landsenkung in der Gegend von Bornholm kann man sich leicht vorstellen. dass grosse Teile des Südbaltikums während der Ancyluszeit trockenes Land waren; die Arkonatiefe mit 40—50 m war dann die grösste Wasserfläche westlich von Bornholm; vielleicht hatte sie aber freie Verbindung mit dem östlichen Ostseebecken durch das Hammerwasser zwischen Sandhammaren in Schonen und Hammer Odde auf Bornholm. Damals war Bornholm über der Rönne Bank und dem Adler-Grund mit Rügen landfest. Auf diese Weise bestand sowohl für die Fauna und Flora wie für die ersten Besiedler gute Möglichkeit zu einer Einwanderung von Norddeutschland nach Dänemark und Schonen.

Auch während der Litorinazeit scheint die Hebung einen unregelmässigen Verlauf gehabt zu haben, der einen tektonischen Einfluss andeutet; z. B. fehlt der Uferwall der Litorinazeit in der südwestlichen Ecke von Schonen bei Skanör und Falsterbo.

Die Literatur, besonders die deutschsprachige, ist ziemlich genau angeführt worden. *Karl A. Grönwall.*

Halden, Bertil E., Einige für die Geotechnik beachtenswerte Erfahrungen betreffs der Verteilung der Bodenarten des kupierten Geländes unterhalb der höchsten marinen Grenze. — Ingeniörsvetenskapsakademien, Handl. nr 73. Auch in einer Festschrift d. königl. Techn. Hochschule in Stockholm. Stockholm 1927. 10 Seiten. Mit engl. Resümee.

Die grossenteils referierende Darstellung hebt besonders die beiden bei Meeresregression entstehenden Arten der Schichtenfolge der Wellensedimente nach der früheren Darlegung des Verfassers hervor: an den exponierten Böschungen Schichten mit gegen die Tiefe abnehmenden Korngrössen, in geschützten Lagen die umgekehrte Ordnung. Als Spezialform dieser Schichtenfolge ist die Ausbildung doppelgründiger Seen zu betrachten, welche ein regionales Charakteristikum der von Regression getroffenen Schärenküsten darstellen. *B. E. Halden.*

Isberg, Orvar, Beitrag zur Kenntnis der postarktischen Landbrücke. — Geografiska Annaler, Bd. IX, 1927, S. 100—108, 1 Textfig.

Verf. berichtet über einen Fund von Baumstümpfen auf dem Boden der Ostsee 13 km südlich von Kåseberga an der Südküste Schonens in einer Tiefe von 35—37 Meter. Torfreste aus einer Höhlung in einem schweren Kiefernstamm sind pollenanalytisch untersucht worden und zeigen Pollenspektra, die deutlich auf eine spätboreale Zeit (Ancyluszeit) hinweisen.

Der Fund zeigt an, dass die Landbrücke zwischen Schweden und Deutschland über Dänemark in der Ancyluszeit eine bedeutend grössere Breite hatte, als die früher nachgewiesene. Bornholm war damals mit Norddeutschland verbunden, und an der Südküste Schwedens erstreckte sich trockenes Land bis zur jetzigen Vierzigmetertiefenkurve herunter. *R. Sandegren.*

MUNTHE, HENR., Studier över Ancylussjöns avlopp (Studies in the Outlets of the Ancylus Lake). S. G. U. Ser. C., N:o 346, 1927, (107 pp., 4 Pls., and several Figs in the text).

As a tolerably detailed Summary in English (Pp. 93—103) ends the paper it may be enough to give here only a very condensed survey of its contents. After a short Introduction there are given some historical dates (Pp. 5—11) as well as the projection and execution of the field work (Pp. 11—13). Then there follows a somewhat detailed description of the main outlets (seven in number) of the Ancylus Lake in the province of Närke (Pp. 13—55), and of their erosion as well as of their deposition of delta-gravel (Pp. 55—62). At last the deposition of the fine-grained sediments in the Let-valley to the west of the outlet district proper are discussed (Pp. 62—69). This chapter ends with some final remarks (Pp. 69—72).

Then the paper contains a review of the (later) outlet of the Ancylus Lake in the South Baltic district (Pp. 72—81), some sketches of the Late-glacial and older Post-glacial development of North Germany and South Scandinavia (Pp. 82—88) followed by an Explanation of a Diagram illustrating the geographical development of the Travemünde district during Glacial and Late-Quaternary times (Pp. 89—92).

At last there are given Bibliographical references (Pp. 105—107).

H. Munthe.

NIHLÉN, J., Gotlands stenåldersboplatser. (Die steinzeitlichen Wohnplätze Gotlands.) Akademisk Avhandling, Uppsala 1927. — Kungl. Vitterhets-, Historie- och Antikvitets-Akademiens Handlingar. Del 36: 3. Sthlm 1927, 234 S., 138 Textfig.

Neben ihren rein archäologischen reichen Ergebnissen gibt die Abhandlung eine Reihe wertvoller Daten zur Kenntnis der Niveauverhältnisse des steinzeitlichen Meeres. Gotland wurde schon vor der Zeit des Litorina-Maximums besiedelt, was durch ein Kulturlager aus Svalings auf der östl. Küste bekannt wurde. In dem 7 cm dicken Kulturlager wurden zwei Feuersteins-Artefakte zusammen mit Knochen von *Halichœrus grypus* gefunden. Das Lager ist von 0.5 m Kies des Litorinameeres überlagert; im Kies wurde eine Reihe mariner Mollusken, unter ihnen auch *Neritina fluviatilis* angetroffen. Svalings liegt etwa 17 m ü. d. M., die Litorina-Grenze liegt 20.5 m ü. d. M., weshalb der Wohnplatz eine Mindesttransgression von 3.5 m andeutet.

Die übrigen Wohnplätze, die öfters mehr als 1,000 Gegenstände enthalten, gehören der Zeit nach dem Litorina-Maximum an. Die ältesten sind hauptsächlich durch Schlagtechnik-Äxte und spez. durch den ostschw. Limhamns-Typus charakterisiert. Daneben kommen auch Walzenbeile und vereinzelt noch jüngere Äxte der jüngeren nordischen Steinzeit vor, was darauf deutet, dass die alten Wohnplätze während längerer Zeit benutzt wurden. Die Schlagtechnik-Äxte hören jedoch bei etwa 85 % der Litorina-Grenze auf. Eine jüngere Gruppe der Wohnplätze ist hauptsächlich durch Walzenbeile charakterisiert, diese hören bei etwa 70 % auf, wenn auch vereinzelte Walzenbeile noch später auftreten [es ist zu bedauern, dass Verf. besonders bez. der Walzenbeile keine typologische Einteilung durchgeführt hat]. Die übrigen und zahlreichsten Wohnplätze gehören hauptsächlich der Ganggräberzeit an. Sie sind besonders durch dicknackige Äxte und reichliches

Fundtabelle der steinzeitlichen Wohnplätze Gotlands. Zusammengestellt von B. Asklund.

Wohnplatz	Niveau Meter ü. d. M.	Litorina-Grenze	% von L.-G.	Lihultäxte	Limhamnsäxte	Walzenbeile	Spitznack. Äxte	Dünnnack. Äxte	Dicknack. Äxte	Jüngere Äxte	Keramik Typus	Bemerkungen
Svalings	17	20,5										Prälitorinal
Norrbys	27,3—23,9	26,5	90	16	87	15			1	1		Grob geschlagen Äxte 180
Nasume	19—17,5	22	80		376	49	4		3	8		Grob geschlagen Äxte 95
Krokstäde	18,2—16,2	21	80	10	109	11	5		1			Übr. Schlagtechn.-Äxte 36
Kroks	18—16,1	20,5	78		224	106	9		3	3		Übr. Schlagtechn.-Äxte 65
Snosarve	14,5	16,5	88						2			
Medebys I			80—90									
Hoffmans			85						2			
Lickers hamn .	18,9	26	73			etwa 20						
(Medebys II . . .	16,1—13,2	20,5	78—64		16	9				2		Die Fundorte unsicher)
Nygårds	13,8—13,6	20,5	67—66	2	1	8						
Gumbalde	10,7	16,5	65								III	
Ire	18,8—17	26	65			9			6		II	
Kinner	15,8	25	63						1		III	
Fridtorp	20,7—14,5	23	90—63			5			1		III?	
Hemmor	9,9	15,5	64		Angaben bei LITHBERG						III	
Ejvide	10,1	17,5	58			2					III	
Gullrum	9	15,2	59		Angaben bei LITHBERG						III	
Hoburgen . . .	5,7	13,7	41									Nur Feuersteinabfälle
Alvena	19—11,2	20,5	55								III	
Visby	16,4—14	23,5	59						2		III—IV	

Vorkommen von Keramikabfall gekennzeichnet. Sie gehen bis auf 50 % des Litorina-Maximums hinunter. Dann hört die »Wohnplatz»-Besiedelung der gotländischen Küsten auf. Verf. diskutiert die Veranlassungen des Aufhörens der »Wohnplatz-Kultur» und sieht darin das Einbrechen eines ungünstigen Klimas. Eine Stütze für diese Hypothese findet er darin, dass die Skelettfunde der Wohnplatzgräber (Visby) nur junge Menschen enthalten, die von *Arthritis chronica deformans* schwer angegriffen sind.

Es gibt Andeutungen, dass der Wohnplatz von Visby während des Anfangs der Ganggräberzeit teilweise transgrediert wurde. Es kommen nämlich Keramikabfall und Tierknochen unter einem Lager von Uferkies vor. Über dem Kies sind auch Keramikabfall und Kulturlager vorhanden, weshalb es offenbar ist, dass der Wohnplatz den Meeresschwankungen gefolgt ist. Wir erhalten damit einen neuen Beleg für die von Ramsay besprochene »zweite» Transgression des steinzeitlichen Meeres während der älteren Ganggräberzeit (die »altbaltische» Transgression von S. A. Jakovleff).

Es ist weiter zu bemerken, dass typische Geräte der Dolmenzeit an den Wohnplätzen kaum beobachtet worden sind. *B. Asklund.*

Nilsson, Tage, En skalbanksstudie i Bohuslän (Research of a Shell-Bed in Bohuslän). G. F. F., Bd. 49, 1927, p. 321 350; Meddel. fr. Lunds Geolog-.Mineralog. Inst., N:o 35.

The shell-gravel deposits of Evensås are situated in a little valley on the eastern shore of the island of Skaftölandet, Bohuslän. The shell-beds are divided in two parts, the A 35-area at the dominating point of the valley about 35 m above the sea, and the B 29-area 100 m further to the SE with its highest parts about 30 m above the sea. The shell-beds have been investigated as to the faunistic composition by using the statistical method of G. De Geer (G. F. F. 1910); yet »absolute» frequencies have been exchanged for relative ones (‰ of the total sum of individuals) in the diagrams and tables.

When during the postglacial time the upheaval of the land had proceeded so far that the neighbouring rocks were reached by the waves, the formation of the sandy or stony bottom-layers of the shell-beds began (at a depth of about 6 m in the A 35-area and 17 m in the higher parts of the B 29-area). Then the accumulation of the shells set in, partly by erosion of older, arctic, shell-bearing clay, partly by washing down of »recent» forms living in the neighbourhood. The redeposited forms at Evensås play a very subordinated role in the statistical analyses. With more or less probability among others the following forms may be redeposited: *Portlandia arctica*, thickshelled *Mya truncata* and *Saxicava arctica*, *Macoma calcarea*, *Astarte elliptica*, *A. Banksii* var. *striata*, *Pecten islandicus*, *Trophon clathratus*. During an earlier period in the development of the shell-beds the valley may have formed a sound with rather strong currents from the open sea in the W. These currents did not touch the A 35-area, which resulted in profound differences between the shell-beds contemporaneously deposited at A 35 and B 29.

The A 35-area was mainly characterized by a sandy and shelly bottom with scanty vegetation. The forms characteristic of the lower B 29-layers (*Saxicava arctica!* etc.) are very sparsely represented at A 35. Further there are lacking forms bound to or preferring vegetation, as *Bittium reticulatum* (!), *Rissoa parva* (!), *Rissostomia membranacea*, *Nassa reticulata*, and *Car-*

dium exiguum. On the other hand such forms are found that only want a sandy bottom, as *Cardium edule, C. fasciatum, Solen ensis, Macoma baltica*, and *Montacuta bidentata*. Among the other forms may be mentioned *Tapes decussatus* (!), *Purpura lapillus, Patella vulgata*, and *Litorina*-species. *Mytilus* and balanids are common in all parts of the shell-beds.

In the B 29-area the stony and rocky shores of the former sound may have been covered with a rich alga vegetation with a fauna of *Saxicava arctica, Onoba striata, Lacuna divaricata, Verruca Stroemii, Balanus porcatus, Acmaea virginea*, and *Anomia squamula* as especially characteristic forms. Besides there are found in these layers *Odostomia*-species, *Thracia villosiuscula, Scrobicularia piperata*, etc.

When the sound was later shut off from the sea in the W through the upheaval of the pass-thresholds (and of the A 35-area), the B 29-area was transformed into a calm bay with a rich Zostera- and Fucus-vegetation. These new edaphic and hydrographic conditions caused corresponding differences as to the fauna, which came to consist of small gastropods as *Bittium reticulatum, Rissoa parva* and other rissoids, further *Nassa reticulata, Litorina*-species, *Cardium exiguum, C. edule, Venus ovata, Macoma baltica, Montacuta bidentata, Tapes decussatus, Ostraea edulis*, etc. — The shell-beds deposited during this period differ in certain stratigraphical respects, too, from the underlying beds, all of which made De Geer (l. c.) interpret these latter layers (and the A 35-beds!) as finiglacial and the former ones as belonging to the postglacial subsidence.

According to the research above reported no such transgression can be proved in the Evensås shell-beds. They may have been deposited during a continuous regression of the sea in a period corresponding to the Tapes-Litorina subsidence in southern Scandinavia and the immediately preceeding time. *Tage Nilsson.*

Odhner, Nils Hj., Några fakta till belysning av skalbanksproblemet. (Einige Ergebnisse zur Beleuchtung des Schalenbankenproblems.) (With a Summary in English.) G. F. F., Bd. 49, S. 77—111.

Eine neue Erklärung der grossen und mehrmals studierten Schalenbänke bei Uddevalla in Bohuslän wird hier vorgelegt. In der reichen boreoarktischen Fossilfauna, welche die Bänke zusammensetzt, dominiert *Balanus hameri*, ein borealer Tiefwasserbewohner. Dieser *Balanus* muss also in der nächsten Umgebung sehr gute Bedingungen gefunden haben. In spätglazialer Zeit lag noch die Senke Uddevalla-Vänersborg unter dem Meeresspiegel. Grosse Mengen von Brackwasser flossen aus dem Väner-Meer durch diesen Sund hinaus. Der ausgehende Strom verursachte einen Reaktionsstrom von salzigem und kaltem Bodenwasser, und dieser richtete sich, durch die tiefen Fjordrinnen vor der Küste hereingeleitet, gegen die Felsenschwelle an der Mündung des Uddevallasundes. Wegen dieser eigenartigen Stromverhältnisse erreichte gerade an dieser Stelle die boreoarktische Bodenfauna ihre ausserordentliche Üppigkeit.

Die Schalen der hier lebenden Tiere wurden bei der Landhebung durch den Wellenschlag von den Felsen niedergespült. Die Schalenbänke sind also, wie Sandegren früher zeigte, Akkumulationsterrassen. Kleine Partien sind aber autochthon; eine derartige Ablagerung bei Kuröd, welche grosse

Mengen von Spongien und kleineren Mollusken enthält, ist nach DE GEERS Methode analysiert worden. Die Analyse gibt keine Auskunft über die Veränderung der Wassertiefe während der Bildung. In den zusammengehäuften Schalenbänken bei Kuröd kann man einen Zonenwechsel feststellen, indem hier die Mytilus-Frequenz in zwei Horizonten merkbar zunimmt. Daraus kann man aber nur auf eine Änderung der Bodenverhältnisse, nicht der Tiefe, schliessen, welche von einer Änderung der Stromzirkulation abhängt. Verlangsamt sich die Stromschwindigkeit, so vermehrt sich die Sedimentation, und Mytilus findet geignete Standorte am Boden. Bei stärkerer Geschwindigkeit wird der Auftrieb von Bodenwasser intensiver, die Sedimente werden weggeführt und eine Frequenzvermehrung von *Balanus hameri* tritt ein.

Diese Stromverhältnisse dauerten an, solange noch der Uddevallasund offen blieb; sobald die Landhebung diesen geschlossen hatte, waren die Voraussetzungen für die boreoarktische Fauna zu Ende. Alle *Balanus hameri*-Bänke bei Uddevalla sind also gleichaltrig, unabhängig von ihrer Höhe ü. d. M., die nur darauf beruht, dass sie in verschiedenen Tiefen angehäuft wurden. Die Fauna der Bänke beweist nur einen Auftrieb von Tiefenwasser, nicht aber eine Senkung des Landes; die Akkumulation der Bänke erfolgte während der Hebung des Landes; somit geben die Schalenbänke keine Stütze für die Annahme einer finiglazialen Senkung.

Ausserdem werden andere Tatsachen behandelt, welche die in der betreffenden Zeit vorherrschenden hydrographischen Verhältnisse beleuchten. Auch die postglazialen Schalenbänke sind in der gleichen Weise gebildet worden, d. h. abgelagert als Akkumulationsterrassen während einer Landhebung und zwar an Orten, wo Strömungen die lebende Fauna bereichert haben. — Eine kurze Diagnose über die von DE GEER schon 1910 benannte, aber unbeschrieben gebliebene *Capulacmaea glacialis* ist dem Resümee beigefügt. *Nils Hj. Odhner.*

VON POST, LENNART. Svea älv (The Svea River). Sveriges Natur 1927, pp. 7—31, 9 figs.

A brief, popularized description of the recently discovered Ancylus Lake outlet, called Svea älv (the Svea River), at Degerfors E. of Lake Vänern. An account of its geology is given by H. MUNTHE in »Studier över Ancylussjöns avlopp» (Studies in the outlets of the Ancylus Lake) and by L. VON POST in »Svea älvs geologiska tidsställning» (The Geological Age of the Svea River). These two papers with English summary, to which here may be referred, are published in the Sveriges Geologiska Undersöknings Årsbok 1927. *Eric Laurell.*

SANTESSON, G., Undersökningar angående det senglaciala havets största utbredning inom Norrbottens län. (Untersuchungen über die grösste Verbreitung des spätglazialen Meeres in Norrbotten.) S. 1—13. Tafl. 1. Sthlm 1927. S. G. U. Ser. C. 348. 8:o.

Der Verfasser hat während topographischer Kartenarbeiten in Norrbotten im Anschluss an die früheren Arbeiten von A. G. HÖGBOM, O. SJÖGREN u. a. den höchsten Strandbildungen des spätglazialen (Baltischen) Meeres nachgeforscht. Diese Strandbildungen treten auf den Berghöhen als Erosionsterrassen, freigespülte Blocksäume und Schwallgrenzen hervor. Die höchste marine Grenze ist an etwa dreissig Stellen bestimmt worden. Im Küstenlande, in der Gegend von Älvsby-Boden-N von Karungi, liegt sie etwa 220 m über dem jetzigen Meeresniveau, sinkt aber gegen Norden und Nordwest und wird in der Gegend von Pitkälahti-Pajala in einer Höhe von 175 m ü. d. Meere angetroffen. Auf der Grundlage der Beobachtungen hat der Verfasser mit Hilfe der topographischen Kartenblätter eine Karte im Massstabe 1: 1,000,000 über die maximale Verbreitung des spätglazialen Meeres in Norrbotten angefertigt, auf welcher auch die Isobasen für je 5 m eingezeichnet worden sind. *K. E. Sahlström.*

THOMASSON, H., Baltiska tidsbestämningar och baltisk tidsindelning vid Kalmarsund. (Zeitbestimmung und Zeiteinteilung des Baltikums in der Kalmar-Gegend.) — Geol. Fören. Förh. Bd. 49, 1927, S. 19—76, Zusammenfassung in deutscher Sprache S. 73—75.

Mit den älteren, von MUNTHE und SUNDELIN ausgeführten Untersuchungen über die Niveauveränderungen der Ostsee in der Kalmar-Gegend als Ausgangspunkt hat Verf. versucht, eine Revision der Baltischen Zeiteinteilung durchzuführen. Die Zeitbestimmungen sind auf Pollenanalysen gegründet, und die verschiedenen Epochen sind an die von L. v. POST für gotländische Lagerfolgen eingeführte Zoneneinteilung angeknüpft. In mehreren Lagerfolgen sind eingehende Analysen der subfossilen Diatomeenflora ausgeführt worden, wodurch teils die Beschaffenheit des Wassers der Ostsee (salziges oder süsses) während verschiedener Stadien, teils die Datierung der Transgressionen und Regressionen im Verhältnis zu den untersuchten Lokalitäten festgestellt worden ist.

Verf. stellt folgende baltische Stadien auf:

1. Der Gyrosigmasee: Subarktisches Süsswasserstadium, durch eine mächtige Transgression charakterisiert. Diese Transgressionsgrenze ist früher als Ancylusgrenze bezeichnet worden.

2. Das Echineismeer: Oligohalines Stadium, durch eine bedeutende Regression beim Übergang zwischen subarktischer und borealer Zeit hervorgerufen.

3. Der Ancylussee (MUNTHE): Süsswasserstadium der borealen Zeit, während des älteren Abschnittes (bis zum Stadium A II) durch Transgression charakterisiert, die zur Ausbildung der Ancylusgrenze (früher zum Teil als Litorinagrenze bezeichnet) führte.

4. Das Mastogloiameer (SUNDELIN): Kurzes Übergangsstadium zwischen borealer und atlantischer Zeit, durch Übergang von süssem zu brackigem Wasser gekennzeichnet. Von einer Lokalität (Ramsås) sind Transgressionsschichten bekannt.

5. Das Litorinameer (MUNTHE): bricht im Anfang der atlantischen Zeit bei Niveau L I der Pollendiagramme ein. Später folgt (bei Niveau L II bei Fågelmara) eine kräftige Transgression, die wahrscheinlich in der Dolmenzeit oder ein wenig früher eintrifft.

Einige ältere Süss- und Salzwasserstadien, die vor dem Gyrosigmasee liegen, beabsichtigt Verf. in einem späteren Aufsatz zu behandeln.

H. Thomasson.

THOMASSON, H., Kolmårdens högre strandlinjer. (Die höheren Uferlinien am Kolmården.) — Geol. Fören. Förh. Bd. 49, 1927, S. 240—258.

Mit diesem Aufsatz beginnt Verf. eine Monographie der Uferbildungen des vorgeschichtlichen Baltikums. Das Untersuchungsgebiet, Kolmården, ist eine hochliegende Gegend im östlichen Teil von Östergötland. Es wird hier mit den höchsten Uferbildungen (zwischen 155 und 95 Meter über dem Meere) angefangen, die dem ältesten Teil der Entwicklungsgeschichte des Baltikums angehören. Da keine Zeitbestimmungen bis jetzt publiziert sind, hat Verf. weder die höchste Grenze des Baltischen Eissees noch die höchste marine Grenze des Gebietes unterschieden, sondern versucht nur eine Anknüpfung an frühere bekannte westlichere Uferlinien, besonders an die der Karlsborger Gegend (Västergötland), herzustellen. *H. Thomasson.*

WALLERIUS, I. D., Några nya iakttagelser inom Linnevikens skalgrusfält. (Neue Beobachtungen über die Schalenablagerungen am Linneviken.) G. F. F. Bd. 49, S. 235—239.

In einem früheren Aufsatz (G. F. F. 1924) hat Verf. die sehr ausgedehnte und artenreiche Schalenablagerung am Linneviken in Bohuslän beschrieben und ihre Bildung diskutiert. Neuere Profile haben ihn veranlasst, hier eine etwas abweichende Erklärung der Entstehung vorzuschlagen, und zwar hinsichtlich des sog. *Balanus*-Kieses unter dem postglazialen Strandkies. Die neuen, westlichen, Profile führen eine rein spätglaziale Fauna, während mehr nach Osten postglaziale Formen mit spätglazialen zusammen auftreten; weiter nach Osten folgt rein postglazialer sog. *Bittium*-Kies. Es liegt somit ein kontinuierlicher Übergang vor vom älteren (spätglazialen) *Balanus*-Kies im W bis zum postglazialen *Bittium*-Kies im O. Die ganze Ablagerung ist so zu erklären, dass ihre Akkumulation am Abhang des Berges während der spätglazialen Landhebung begann, und zwar auch in vertikaler Richtung fortschritt, bis in postglazialer Zeit schliesslich ein Lehmlager die Schalenbank überdeckte; dann ist sie von oben an erodiert und wieder als Strandkies abgelagert worden. Ihre Entstehung erklärt sich also ohne Zuhilfenahme einer Landsenkungshypothese. — Einige neue Molluskenfunde werden erwähnt; die Gesamtzahl der fossilen Arten an dieser Lokalität beträgt damit 107. *N. Hj. Odhner.*

Biogéologie.

ASSARSSON, G., Fossilt pollen av Trapa natans (Subfossiles Pollen von Trapa natans.) Geol. Fören. Förh. Bd 49, 1927, S. 293, 1 Textfig.

In den Gyttjaschichten der Vorseen in der Gegend von Gusum (Östergötland) wurden Pollenkörner von *Trapa natans* gefunden. Einige Lagerfolgen wurden pollenanalytisch untersucht, um mittels dieses leicht erkennbaren Tetradenpollens die Einwanderungszeit der Wassernuss zu bestimmen. Auf diese Weise wurde festgestellt, dass das erste Auftreten der Wassernuss in dieser Gegend zur Zeit des Litorinamaximums eingetroffen ist.

G. Assarsson.

Elfstrand, M., Var hava fanerogama växter överlevat sista istiden i Skandinavien? (Where have phanerogams survived the last glaciation in Scandinavia?) Svensk Botanisk Tidskrift, Bd 21, pp. 269—284, 3 plates, 1927.

A very rich *Hieracium*-flora is found on the Vaddasgaisa mountain at the Norwegian coast 100 km ENE of Tromsö. Some of its species do not occur elsewhere in Scandinavia, but nearly identical forms are found in the eastern and southern Carpathians. It seems probable, therefore, that the Norwegian species form a remnant of a relatively old *Hieracium*-flora which lived beyond the ice margin and between that margin and the East-Carpathians during the Great Ice Age. At the regression of the ice and during the last Interglacial epoch some of these *Hieracias* advanced, spreading over certain parts of Fennoscandia, and growing there in nearly the same forms as in the Carpathians. During the last glaciation only a few species were able to survive on some now submerged coast banks off the Norwegian coast and near some deep fjords, to which the warm Gulf-Stream water had free access. At two places near the coast of Norway (viz. at Vesteraaleggen outside of the Lofoten islands and at Storeggen off the coast SW of Trondhjem) the sea bottom slopes steeply from 200 to 1,000 and 2,000 m. The distribution of »bicentric» species is chiefly restricted to districts not far from these slopes. This is to be correlated with the fact that the mild influence of the Gulf-Stream water was more marked here than in the neighbouring districts during the Ice Age.

G. Erdtman.

Erdtman, G., Literature on Pollen-statistics published before 1927. Geol. Fören. Förh., Bd 49, 1927, pp. 196—211, 2 plates.

Ein Verzeichnis der bis Ende 1926 erschienenen Arbeiten, worin Resultate von pollenanalytischen Untersuchungen mitgeteilt worden sind. Die Gegenden, wo derartige Untersuchungen vorgenommen sind, sind auf eine Karte eingetragen worden. An das Verzeichnis schliessen sich 18 Abbildungen von den Pollenkörnern, die am häufigsten in den Torfmooren angetroffen werden.

G. Erdtman.

Erdtman, G., Tapesgränsen på Jæderen och dess relation till skogarnas historia i sydvästra Norge, jämte några anteckningar om Najas flexilis. (Die Tapesgrenze auf Jæderen und ihre Relation zur Geschichte der Wälder im südwestlichen Norwegen, nebst einigen Notizen über Najas flexilis.) Svensk Botanisk Tidskrift, Bd. 21, pp. 83—88.

Nach pollenanalytischen Untersuchungen von Torfmooren in Jæderen im südwestlichen Norwegen scheinen die Waldbäume in folgender Ordnung eingewandert zu sein: zuerst *Betula* und *Pinus*, dann der Reihe nach *Corylus*, *Ulmus*, *Alnus*, *Quercus* und *Tilia*. Wie aus einem Aufschluss unfern Harestad hervorgeht (ein Uferwall über Birkenwaldtorf und Gyttja), wanderten diese Bäume noch vor dem Maximum der postglazialen Senkung ein. Die Funde von *Najas flexilis* in Jæderen scheinen in Analogie mit vielen Funden aus Schweden, Schottland, Deutschland u. s. w. borealen Alters zu sein.

G. Erdtman.

Erdtman, G., Exkursioner i Auvergne. (Exkursionen in der Auvergne.) Svensk Botanisk Tidskrift, Bd. 21, pp. 88—91, 1 Textfig.

Durch pollenstatistische Untersuchungen ist folgende Reihenfolge für die Einwanderung der Waldbäume in die Auvergne erwiesen worden: 1. *Pinus*, *Betula;* 2. *Corylus*, *Quercus*, *Ulmus;* 3. *Tilia;* 4. *Alnus;* 5. *Abies*, *Fagus;* 6. *Carpinus*. Näheres in »Premières analyses polliniques effectuées dans les tourbières auvergnates» (Archives de Botanique, p. 201—216, Caen 1927) von M. Denis, G. Erdtman und F. Firbas. *G. Erdtman.*

Erdtman, G., En pollenanalytisk undersökning av torvprov från Jadebukten och Weserestuariet. — Svensk Botanisk Tidskrift, Bd. 21, S. 91.

Eine pollenanalytische Untersuchung von Torfproben aus der Jadebuch und dem Weserästuarium. Über diese Untersuchung ist später ausführlicher in dieser Zeitschrift in deutscher Sprache berichtet worden. (Geol. Fören. Förhandl. Bd. 50, 1928, S. 378, 379). *G. Erdtman.*

Erdtman, G., De skotska torvmarkernas »Second Arctic Bed». Ett bidrag till en omstridd växtgeografisk och klimatologisk fråga. — Svensk Botanisk Tidskrift, Bd. 21, pp. 242—246.

With their débris of »xerophilous» plants the »Second Arctic Beds» in the Scottish peat deposits have been regarded as formed during a cold, dry period. According to the author, however, these beds were formed during the warm and moist atlantic period during which the Carse-clay of the Forth- and Tay-districts was deposited. The Second Arctic Beds are in most cases found in peat deposits of soligenous type. The development of such peats is hastened by oceanic climates, but only to a certain degree, as, with an excessive precipitation the formation of peat ceases altogether. Owing to the increase of precipitation during atlantic time the formation of peat may have ceased in many places. Later, when new peat has formed during a succeeding period of less precipitation, these atlantic surfaces will appear in section as if they were horizons representing dry conditions and not in their true character as fossil witnesses of an oceanic climate. During atlantic time also subalpine and alpine plants would be swept down more easily by floods to lower levels, where they would eventually be able to colonize the naked peat, made ready by previous erosion and decay. *G. Erdtman.*

Gertz, Otto, Stratigrafiska och paleontologiska studier över torvmossar i södra Skåne. I, II. (Stratigraphische und paläontologische Studien über Torfmoore im südlichen Schonen. I, II.) — Bilaga til redogörelse för Lunds högre allmänna läroverk under läsåren 1925—1926 och 1926—1927. Auch veröffentlicht als »Meddelanden från Lunds Universitets Geologisk-mineralogiska Institution» N:o 30—31. 134 Seiten.

Die Arbeit liefert zuerst eine Übersicht über die Geschichte der Torfmoorforschung, insbesondere Schwedens, und gibt dabei eine ausführliche Auseinandersetzung der wichtigsten Epochen der Entwicklung dieser Wissenschaft, von Steenstrups und Nathorsts klassischen Untersuchungen bis auf die gegenwärtigen, wesentlich durch die Methode der Pollenanalyse bedingten Forschungen von LENNART VON POST. Die vom Verf. untersuchten Torfmoore, 17 verschiedene Lokalitäten, liegen sämtlich südlich von der Grenzlinie zwischen Fenno-Scandia und Scano-Dania und gehören den geologischen Kartensektionen Lund, Börringekloster, Trelleborg, Ystad und Sövdeborg an. Sie sind sowohl stratigraphisch wie auch paläontologisch, und zwar im wesentlichen von paläofloristischem Gesichtspunkte aus, Schicht nach Schicht, nach den von NATHORST und GUNNAR ANDERSSON beschriebenen Arbeitsmethoden eingehend untersucht worden. Angeführt werden in Details die fossilen, pflanzlichen wie tierischen Reste der einzelnen Schichten, mit Ausnahme derjenigen der Oberfläche der betreffenden Moore, die im allgemeinen unberücksichtigt geblieben sind, weil sie, wie überhaupt in den Torfmooren Schonens, zum Zweck der Brenntorfgewinnung dekapitiert und durch rezente Torfbildung sekundär regeneriert worden sind. Die Bestimmung der Moose verdankt der Verf. Herrn Lektor Dr. HJ. MÖLLER (Stockholm), diejenige der Skelettteile von Vertebraten den Herren Museumsinspektor H. WINGE (Kopenhagen) und Fischereiintendent Dr. N. ROSÉN (Gotenburg); die Molluskenschalen haben die Herren Dr. A. C. JOHANSEN (Kopenhagen) und Phil. Mag. H. LOHMANDER (Lund) bestimmt. Von den beschriebenen Torfmoorlokalitäten sind einige in Zusammenarbeit mit den Landesgeologen Dr. N. O. HOLST und Dr. A. H. WESTERGÅRD vom Verf. untersucht worden.

Der Bau der Moore weist im ganzen untersuchten Gebiet fast durchgängig denselben Typus auf. Die Schichtenfolge ist demnach: 1. Ton, bezw. Sand spätglazialen Alters, 2. Gyttja-Schicht, Lebertorf (Detritus-Gyttja), der örtlich z. T. durch Wiesenkalk oder durch Torfränder wechselnder Mächtigkeit substituiert ist, 3. Torf in verschiedenen Varianten. Bei Gärdslöv erreicht die Gyttja eine staunenswerte Mächtigkeit, etwa 3 m. Bei Skurup untersuchte der Verf. ein Torfmoor, das durch das Fehlen des sonst stets vorhandenen Lebertorfs und durch das Auftreten von Torfschichten mit *Arctostaphylos uva ursi*, *Myrtillus uliginosa*, *Oxycoccus palustris* und anderen Charakterpflanzen eines oligotrophen Bodens von dem im Gebiete immer vorherrschenden eutrophen Torfmoortypus auffallend abweicht. Bei Lomma kommt eine durch Brackwasserfazies charakterisierte lokale Torfbildung vor, die nach den Untersuchungen des Verf.'s mit den von Dr. K. KJELLMARK (1903) bei dem Järavallen in Limhamn gefundenen Torfschichten, sowie auch mit einer von Dr. L. VON POST (1903) beschriebenen Lokalität beim Mästermyr im südlichen Gotland zu parallelisieren ist. Eine durch die Bildung von Kalktuff unterbrochene Torfablagerung kommt bei Steglarp vor; bei Almaröd wurde im Torf eine Bildung von Eisenocker festgestellt. Eingehend beschrieben wird eine von Schutt und Sand bedeckte, in gewissem Grade mit den submarinen Torfmooren der Ostseeküste äquivalierende Ablagerung von Torf bei Skateholm, die auch deshalb ein besonderes Interesse darbietet, weil Süsswasser- und Brackwasserschichten abwechseln. Auffallend ist ferner, dass die Torfbildung hier verhältnismässig spät anfängt. Die spätglazialen Schichten und die Ablagerungen der Espen- und Kiefernzeit sind nämlich nicht vorhanden, und oberhalb des Sandes, der den Boden des betreffenden Moorbeckens bildet, treten schon die Ablagerungen der Eichenzone auf. Der Torf stellt in seinem unteren Teil eine reine Süsswasserbildung dar; die danach folgenden Gyttja-Schichten sind dagegen in brackigem Wasser entstanden, mit Ausnahme der obersten, welche wie der obere Torf wieder in Süsswasser gebildet sind. Die Wechsellagerung von einzelnen, in salzigem und in süssem Wasser gebildeten Schichten, die bei Skateholm auch in anderer Weise zum Vorschein kommen, deutet auf eine interessante Oszillation des Litorinameeres zur Zeit der Kulmination der postglazialen Senkung hin.

Hinsichtlich der speziellen paläontologischen Funde sei folgendes mitgeteilt. Im Torfmoor bei Toppeladugård wurde in der *Dryas*-Zone *Pinus silvestris* (Zapfen, Nadeln, Rinde) zusammen mit Blättern von *Dryas* und *Betula nana* gefunden (Alleröd-Oszillation). *Trapa natans* kommt bei Gärdslöv, Kallsjö und Elinelund vor. Die in diesen Mooren gefundenen *Trapa*-Früchte hören zu dem *coronata*-Typus, einzelne derselben zu der Subforma *elongata*. Bei Kallsjö und Elinelund wurden auch *Trapa*-Früchte mit anomaler Ausbildung beobachtet, die offenbar durch »Dédoublement» bedingt ist. *Cladium Mariscus*, *Najas marina*, *Ceratophyllum* u. a. sind in den untersuchten Mooren wiederholt gefunden worden. An der Hand seiner Beschreibung des paläontologisch interessanten Torfmoors Sote Mosse (Önnarp) und der an dieser seit Sven Nilssons Tagen klassischen Lokalität nachgewiesenen Fossilien bespricht der Verf. eingehend einen Fund von *Carpinus Betulus* im oberen Teil des Lebertorfs. Von dieser bisher in Schweden als fossil unbekannten Pflanze wurde ein Nüsschen gefunden, in einer Schicht, die auch *Pinus silvestris*, *Populus tremula*, *Alnus glutinosa*, *Acer platanoides*, *Cladium Mariscus*, *Ceratophyllum demersum*, *C. submersum* u. a. enthielt. Der Verf. knüpft an den betreffenden Fund eine Diskussion über das paläontologische Verhalten des *Carpinus Betulus* an, der demnach ein verhältnismässig frühzeitiger Einwanderer zu sein scheint. Pyritisierte Pflanzenreste kommen massenhaft in den spätglazialen Schichten bei Mossby vor. Pyritisierung zeigten ferner auch einzelne Pflanzenteile aus der Gyttja bei Skateholm.

Unter den vom Verf. beschriebenen Vertebratenfunden sind folgende besonders hervorzuheben: *Arvicola amphibius* (Saritslöv, Skateholm), *Anser sp.* (Moor bei Allarp in Södervidinge, Sandåkra), *Cygnus sp.* (Örsjö), *Podiceps cristatus* (Sote mosse bei Önnarp), *Tringa alpina* (Skateholm), *Bufo* und *Rana sp.* (Hassle Bösarp). Daneben werden ältere, die fraglichen Moore betreffende Fundangaben, z. B. von *Bos primigenius*, *Rangifer tarandus*, *Cervus elaphus*, *Emys orbicularis* u. a., vom Verf. zusammengestellt. — Für verschiedene in fossilem Zustande gefundene Zoo- und Phytocecidien werden Beobachtungen angeführt.

Einzelne Details der erwähnten Untersuchungen sind schon vorher, z. T. vom Verf., z. T. von den Landesgeologen Dr. N. O. Holst und Dr. A. H. Westergård, veröffentlicht worden. *Otto Gertz.*

Lundqvist, G., Örträsket och dess tappningskatastrofer. (Der See Örträsket und die Entleerungskatastrophen desselben.) Mit deutschem Resümee. — Sv. Geol. Unders., Ser. C, N:o 340, Årsbok 20 (1926).

Der See Örträsket im Kirchspiel Norsjö, Västerbotten, gehört dem Stromgebiet der Skellefteälv an. Der natürliche Abfluss ging zur Skellefteälv hin, 1884 wünschte man aber den See für Flösszwecke nutzbar zu machen und leitete das Wasser desselben nach dem Fluss Malån ab. Dabei schnitt sich das Abflusswasser ein so tiefes Bett, dass der See fast entleert wurde. Spuren von dieser Katastrophe sieht man noch (Torfblöcke, Sandfelder, Ravinen usw.). — Der See wurde jedoch durch einen za. 10 m hohen Damm wieder aufgestaut, der indessen untergraben wurde und am 11. Juni 1926 barst. Die Kapitelüberschriften des vorliegenden Aufsatzes sind folgende: Einleitung, Arbeitsmethoden, Topographische Übersicht, Die Biologie des Sees Örträsket und seine Entwicklungsgeschichte (Wasserbeschaffenheit, Plankton, Höhere Vegetation, Rezente und oberflächliche Sedimente,Fossile Sedimente, Altersbestimmungen, Mikrofossilanalysen, Deutung der Lagerfolgen), Entleerungskatastrophe 1884, Entleerungskatastrophe 1926 (Allgemeine Übersicht, Topographische Veränderungen, Die Entleerungssedimente), Die Hydrographie der Entleerung.

Der See war humusmesotroph, und seine Sedimente waren Seeerz, Diatomeenocker, Dygyttja und Gyttja. Die Bildung dieser Sedimente begann während postarktischer, wahrscheinlich atlantischer Zeit (Pollendiagramme sind beigegeben), woraus der Schluss gezogen wird, dass der See während der genannten Zeit beträchtlich transgrediert ist.

Die Resultate der Entleerung 1926, die etwa 2 Stunden in Anspruch nahm, werden durch Figuren und eine Karte (1: 6,000) über die Proximalpartie des Katastrophengebiets beleuchtet. Das Areal des Sees wurde von 0.44 auf 0.1 km² vermindert, und die Gesamtsenkung der Oberfläche war im NW za. 9 m und im SO za. 13 m. Er war auf 1.7 m über die Hochwasserlinie aufgestaut und reichte daher in die Depressionen der Umgebung hinein. Die Ravinen, die jetzt in dem blossgelegten Grunde zu sehen sind, wurden während der Senkung des Wasserspiegels herauserodiert; sie sind gewöhnlich ausserhalb solcher Depressionen gelegen und müssen durch den Abfluss des Oberflächenwassers gebildet worden sein. Nur ein unbedeutender Teil des Seebodens blieb unberührt (Karte). — Ausserhalb des Seegebiets fand im ganzen eine Akkumulation statt von Sand (Strukturanalyse), Torfblöcken (losgebrochen aus einem Moor, das der Entleerungsstrom passierte) bis zu einer Grösse von 12 × 3 × 3 m, Holzstücken und umgebrochenen Baumstämmen. Die Mächtigkeit des Entleerungsstroms betrug höchstens 5 m und seine Geschwindigkeit im oberen Teile za. 10 km, im unteren za. 1.5 km/Std. Entleerungssedimente waren bis herunter zum Bottnischen Meerbusen (80—90 km weit) zu sehen und verursachten grosse Schwierigkeiten für den Betrieb einiger Industrien. *G. Lundqvist.*

Étude des sols et Géologie agricole.

De Geer, G., Byggnadsgrund ur geologisk synpunkt. (The foundation of buildings from a geological point of view.) Ur: Byggnadskonst III, H. Kreüger. A. Bonniers förlag. Stockholm 1927 pp. 7—24.

This chapter from H. Kreügers great manual: The art of building, deals with such sides of Swedish geology which pertain to this subject. Thus it is mentioned, with respect to the bed-rocks, the occurrence of dangerous fissures and slantings of great boulders simulating reliable bedrocks. As to the loose deposits their mode of formation is indicated in a short introduction, followed by a somewhat detailed description of the more important different deposits.

In connection with a diagram containing a systematic exposition of all the Quaternary formations and landforms some indications are given in order to facilitate an always desirable selfinstruction.

The article ends with a synopsis of mechanical analyses of different deposits as far as possible consequently classified as to their coarseness, which is ordinarily rather neglected. *G. De Geer.*

Ekström, Gunnar, Klassifikation av svenska åkerjordar. (Die Klassifikation der schwedischen Ackerbodenarten.) Sveriges geologiska undersökning. Ser. C. N:o 345. Årsbok 20. 1927. 161 S. 25 Fig. Stockholm. (Schwedisch; Akademische Abhandlung).

I. Die verschiedenen Arten von Bodeneinteilungen.

(Genetisch-dynamische, petrographische, mineralogische, lithologische, chemische, pflanzenphysiologische, praktische und klimatologische Bodenklassifikationen u. s. w.)

II. Die Bodenbestandteile und deren Eigenschaften.

A. Die Konstituenten der Mineralböden oder die Kornfraktionen (nach Atterberg): Stein (20—2 cm), Kies (20—2 mm), Sand (2—0.2 mm), Grobsand (2—0.6 mm), Mittelsand (0.6—0.2 mm), Mo oder Feinsand (0.2—0.02 mm), Grobmo (0.2—0.06 mm), Feinmo (0.06—0.02), Schluff (20—2 μ), Mikroton (2—0.2 μ) und Ultraton oder Kolloidton ($< 0.2\ \mu$).

B. Die organogenen Komponenten oder Humusformen (nach H. von Post, Sernander, Hesselman, Odén u. a.) sind:

Förna (die abgestorbenen, unveränderten Reste von Pflanzen und Tieren), Torf, Moder, Gyttja-Substanz (Schlick), Dy (Humusstoffe) und Mull (= Humus der Ackerkrume). — Humus wird als Kollektivnamen benutzt.

III. Auf Grundlage der Klassifikationssysteme von A. Atterberg und S. Johansson u. a. legt der Verfasser einen Vorschlag zur Bodenarteneinteilung nach der mechanischen Zusammensetzung vor. Die Haupteinteilung geschieht nach Humus- und Tongehalt. In diesem Referate werden nur die aus landwirtschaftlichem Gesichtspunkt wichtigsten Bodenklassen berücksichtigt. — Die Bodenarten, die teils Ackerkrumeböden, teils Untergrundböden sind, werden nach folgendem Schema klassifiziert.

Untergrundböden. A. Mineralböden (< za. 1 % Humus).

a) Sortierte oder unvollständig sortierte Mineralböden: Stein-, Kies-, Sand-, Grobmo, Feinmo- und Schluffbodenarten, Leichter Ton, Mittelschwerer Ton, Schwerer Ton und Sehr schwerer Ton.

b) Unsortierte Mineralböden oder Moränenböden:

Tonfreie Moränenböden (Moränenmo) und Moränentone.

B. Humusgemischte Mineralböden: Gyttjehaltige, leichtere und schwerere Tone u. a.

C. Mineralgemischte Humusböden: Tonhaltige Gyttjeböden u. a.

D. Humusböden: Gyttja, Dy und die verschiedenen Arten von Torfböden.

Ackerkrumeböden.

A. Mullgemischte Mineralböden (< 15 % Mull), die in mullarme (< 3 %), mullhaltige (3—6 %) und mullreiche (6—15 %) Böden eingeteilt werden

z. B. mullarmer Schluff, mullhaltiger Moränenton, mullreicher schwerer Ton . s. w.).

B. Sandige oder tonhaltige Mullböden oder Torfböden (15—40 % Humus).

C. Mullböden oder Torfböden (> 40 % Humus).

IV. Die Laboratoriumsmethoden.

Die mechanische Bodenanalyse (die Schlämmanalyse nach ATTERBERG) ird verwendet, um die tonfreien Mineralböden voneinander zu trennen. ie Wegnahme von Humus geschieht durch die H_2O_2-Vorbehandlung (nach OBINSON). Die Tonaggregate werden mittels wiederholten Bürstens mit chwach H_3N-haltigem Wasser zerteilt. Limonithaltige Aggregate werden lurch Schütteln mit saurem Kaliumoxalat zersetzt. Der Zusammenhang wischen Tongehalt und Hygroskopizität wurde studiert (Fig. 8 in der Abandlung).

Die (humusfreien) Mineralböden und besonders die Tone werden durch ie Hygroskopizitätsmethode nach MITSCHERLICH klassifiziert. Die folgenlen Grenzen hat der Verfasser aufgestellt:

	W_h
Tonfreie Mineralböden	< 2
Leichter Ton (Lehm)	2— 4
Mittelschwerer Ton	4— 7
Schwerer Ton	7—10
Sehr schwerer Ton	> 10

Die höchsten Hygroskopizitätsziffern für die schwedischen, quartären one sind 16 bis 17. — Mit Hilfe der Hygroskopizität werden auch die mullemischten Mineralböden klassifiziert. Unter Annahme, dass die Hygroskoizität der Mullsubstanz 50 ist, kann nämlich die Hygroskopizität für die ineralsubstanz in der Ackerkrume ($W_{h\ min.}$) berechnet werden. Als ygroskopizitätsapparate werden grössere Vakuumexsikkatoren benutzt. ls Trocknungsexsikkator wendet der Verfasser einen besonders konstruierten etallexsikkator (Fig. 9) an, der zehn Schälchen enthält. Der Verfasser hat ezeigt, dass man verschiedene Hygroskopizitätswerte von einer und derelben Probe erhält, wenn die Gläschen in einem grösseren Exsikkator auf erschiedenen Höhen über der Schwefelsäure stehen (Fig. 10).

Mehrere Klassifikationsmethoden, wie Fliessgrenze, Plastizitätszahl (AT-ERBERG), Feinheitszahl (der Geotechnischen Kommission) u. s. w., gründen ich auf Wassergehaltsbestimmungen bei einer gewissen Konsistenz eines onteiges. Der Verfasser hat gezeigt, dass diese Methoden keine zuverlässien Werte betreffs des Feinheitsgrades oder Gehaltes an kolloidalen Tonparikelchen liefern. Um einen homogenen Tonteig zu bekommen, muss man en pulverisierten Ton mit Wasser kneten. Die Fehlerquelle gründet sich nter anderem darauf, dass es praktisch genommen unmöglich ist, die kleieren Tonaggregate oder Sekundärpartikelchen in Primärpartikelchen beim neten aufzuteilen.

Die exakten quantitativen Humusbestimmungen werden nach der Mehode DENNSTEDT's ausgeführt. Die Glühverlustbestimmungen geben jedoch ir praktisches Bedürfnis genügend sorgfältige Werte des Mullgehaltes, enn nur der Glühverlust um gewisse Einheiten, verschieden für Böden mit ngleichem Tongehalt, vermindert wird. Der Unterschied zwischen Glüherlust und Mullgehalt für die verschiedenen mullgemischten Mineralböden t nämlich folgender:

Mullgemischter, tonfreier Boden	0.4—1.2 = 1
» leichter Ton	1.4—2.2 = 2
» mittelschwerer Ton	2.0—2.9 = 2.5
» schwerer Ton	2.9—4.4 = 3.5
» sehr schwerer Ton	3.9—5.3 = 4.5

Die Tabellen 1 und 2 am Ende der Abhandlung enthalten Analysen von 90 Untergrundböden und 54 Ackerkrumeböden. Die Tabelle 4 ist die Tabelle der Geotechnischen Kommission der schwedischen Staatsbahnen für Berechnung der relativen Festigkeitszahl (und Feinheitszahl), teilweise von John Olsson im Jahre 1927 umgearbeitet.

Der Verfasser hofft in einer anderen, später herauskommenden Abhandlung auf Deutsch ein ausführliches Referat geben zu können.

G. Ekström.

Johansson, Simon, Tjälproblemet och programmet för dess lösande. (Das Bodenfrostproblem und das Programm für dessen Lösung.) Vortrag auf der Jahresversammlung des schwedischen Wegvereins 31. Mai 1927). — Svenska Vägföreningens Tidskrift, 1927, S. 315—322.

Verf. referiert zuerst die durch die Untersuchungen von B. Högbom, A. Hamberg u. a. bekannten arktischen Frostphänomene, aus welchen die ungeheure mögliche Stärke der Frostwirkungen erhellt. Aber auch in temperierten Gebieten stellen sich bedeutungsvolle Frostwirkungen ein, die ja u. a. die Landstrassen und Eisenbahnen beschädigen (Frosthebung des Bodens und sog. »Tjälskott», eine besondere Destruktionsform der Wege beim Schmelzen des Bodenfrostes). Die (damals) neuerdings begonnenen Untersuchungen über die Ursache dieser Phänomene (der Frosthebung) haben den Verlauf des fraglichen Prozesses in den Hauptzügen klargestellt.

Verf. gibt die durch genaue Feldbeobachtungen und Laboratoriumsversuche bestätigte präliminäre Theorie der Bodenfrostbildung und -Hebung wieder: Eine gefrorene feinkörnige Bodenart ist von einem System aus im ganzen horizontalorientierten Schichten aus reinem Eis durchzogen. An der unteren Grenze des gefrierenden Bodens erfolgt unter gewissen Bedingungen eine als Eis sich ablagernde Wasserzufuhr, die die Frosthebung verursacht. Diese Wasserzufuhr geschieht hauptsächlich kapillar von unten (wie Verf. schon früher hervorgehoben hat). In einer dünnen Zone relativer Trockenheit unmittelbar unterhalb der Bodenfrostgrenze aber geschieht die Wasserzufuhr durch Diffusionsströmung und Kondensation nach dem »Gesetz der kalten Wand». (Spätere Berechnungen haben gezeigt, dass eine solche Diffusion nur einen sehr kleinen Teil des empirisch konstatierten Wassertransportes erklären kann; der Transport durch Diffusion geschieht wahrscheinlich nur über mikroskopisch kurze Strecken, im übrigen durch ein »Kriechen» des Adsorptionswassers. Anm. des Referenten.) Die treibende Kraft ist die Kapillarkraft, die durch das partielle Austrocknen aktiviert wird. Die Grundwassertiefe bedeutet darum sehr viel für die Grösse der Wasseranreicherung und damit für die Frosthebung und »Tjälskotts»-Bildung.

Im übrigen enthielt der Vortrag eine Skizzierung des künftigen Arbeitsprogrammes.

G. Beskow.

MALMSTRÖM, C. & TAMM, O., Försöksparken Kulbäcksliden. (Der Versuchspark Kulbäcksliden.) Program för Svenska Skogsvårdsföreningens och Norrlands Skogsvårdsförbunds exkursion till Västerbotten 19—21 juni 1907. Stockholm 1927.

In einem Exkursionsprogramm, das für einen Besuch des schwedischen Forstvereins und des »Norrlands Skogsvårdsförbund» verfasst wurde, ist teils eine kurze Beschreibung des Versuchsparks Kulbäcksliden (mit botanischer Karte, 1 : 20 000) gegeben, teils eine ziemlich ausführliche, vorläufige Mitteilung über die mehrjährigen wissenschaftlichen Studien der Forstlichen Versuchsanstalt Schwedens über die Waldversumpfung vorgelegt. Dabei ist auch ein Referat einiger Teile der Monographie: Degerö Stormyr von C. MALMSTRÖM (Mitteil. der Forstl. Versuchsanstalt Schwedens. Heft 20, 1923, S. 3—205) mit einbegriffen, weil diese Teile grosse Bedeutung für das Verständnis der Waldversumpfung haben.

Die Forstliche Versuchsanstalt Schwedens hat zwei Versuchsfelder in Nordschweden angelegt, um das befürchtete Fortschreiten der Waldversumpfung zu studieren. Das eine findet sich in Kulbäcksliden, Västerbotten, das andere in Rokliden, Norrbotten. Man untersuchte dort: 1. Den Grundwasserstand und dessen Veränderungen und die Bewegungen des Grundwassers. 2. Die Bodentypen und deren physikalische und chemische Eigenschaften. 3. Die Zusammensetzung und Verteilung der Vegetation der Torfböden und deren Umgebungen. 4. Pollenanalytische Verhältnisse in den Torflagern. Grundwasserstudien, Bodenstudien und Vegetationsaufnahmen wurden von G. ANDERSSON und H. HESSELMAN begonnen. Das Ganze wurde später an O. TAMM (Bodentypen, Grundwasseruntersuchungen) und C. MALMSTRÖM (Vegetation, Torf, Grundwasserstand) überlassen.

Die Grundwasseruntersuchungen haben gezeigt, dass die Waldversumpfung in enger Beziehung zum Grundwasserstand steht. Die Grundwasserbewegungen in den Moränen sind indessen sehr langsam, und eine Grundwasserlieferung von einer torfgefüllten Vertiefung im Moränengebiet an ihre Umgebungen ist ausgeschlossen.

Die Bodenuntersuchungen haben erwiesen, dass die Versumpfung auf grossen, zentralen Flecken entstanden ist, wo das Grundwasser von Anfang an bis zur Bodenoberfläche gestanden hat. Deshalb gibt es hier keine Podsolierung. Diese Flecken sind von Humuspodsolsäumen umgeben. Die trockensten Gebiete haben Eisenpodsol. Wahrscheinlich ist die Waldversumpfung sogleich nach dem Abschmelzen des Inlandeises entstanden und hat dabei wenigstens die zentralen, unpodsolierten Gebiete betroffen. Diese Gebiete stellen einen grossen Teil des jetzt versumpften Areals dar.

Die Vegetationsstudien bestehen zum Teil in Untersuchungen über die Pflanzengesellschaften. Sie haben mehrere wichtige Beiträge zur Einteilung und Ökologie der torfbildenden Pflanzengesellschaften geliefert. Auch wurden direkte Untersuchungen über den Zuwachs während zwanzig Jahren von Sphagnumpolstern im Grenzgebiet der Versumpfungen angestellt. Durch diese Untersuchungen konnte kein Vordringen der Waldversumpfung nachgewiesen werden.

Die pollenanalytischen Untersuchungen der Torflager haben erwiesen, dass die grössten Teile sowohl von Degerö Stormyr als von den kleineren Torfflecken des Versuchsfelds schon bei der Einwanderung der Fichte torfbedeckt waren. Dies fand, wie man annimmt, vor etwa 4,000 Jahren statt.

Die präabiegnen Flächen decken ungefähr die Flecken von unpodsoliertem Boden. Es besteht somit eine sehr gute Übereinstimmung zwischen den Resultaten der zwei ganz verschiedenen Wege zur Bestimmung des Platzes der ältesten Versumpfung. Es ist nur ein verhältnismässig schmaler Streifen von Boden, den die Versumpfung während der letzten 4,000 Jahre erobert hat. Es scheint der Schluss gerechtfertigt, dass die Waldversumpfung jetzt zum Stillstand gebracht ist oder sich sehr langsam, »asymptotisch», einem Stillstand nähert. Das stimmt gut mit einer Reihe anderer Beobachtungen überein.

Die Schlüsse aus den Untersuchungen dürften Gültigkeit für die grossen Moränengebiete im inneren Norrland haben. Zufälligerweise sind indessen von verschiedenen Personen Beobachtungen über schnell fortschreitende Versumpfungen gemacht worden. Solche kommen zuweilen vor, wo Quellwasser gestaut worden ist, und auch in anderen Fällen. Im allgemeinen muss jedoch die Gefahr der Waldversumpfung in Nordschweden als sehr übertrieben angesehen werden. *O. Tamm.*

TAMM, O., & MALMSTRÖM, C., The Experimental Forests of Kulbäcksliden and Svartberget in North Sweden. 1. Geology (TAMM). 2. Vegetation (MALMSTRÖM). Statens Skogsförsöksanstalts exkursionsledare XI, Stockholm 1926.

The paper consists of descriptions and maps (1:20 000), both geological and botanical ones, of two forests (each about 1 000 hectares) which are situated in the neighbourhood of Vindeln in North Sweden. The geology is investigated specially from the forestry point of view, but also general observations are made. The rocks are Archæan gneisses. The Quaternary deposits consist of moraines, sands, gravel, silt, clay and peat. The limit of the late Quaternary sea was determined with accuracy. It is developed as an erosion line and also as the upper limit of the occurrence of sand areas and of moraines which are subjected to a slight washing by waves. An account is given of the different types of soil profile, found at the investigated areas.

The vegetation was divided into forests, bog-plant associations and plant communities of the waters. The forests were treated much more in detail than the other and divided in a number of different types, which were mapped. A complete list of the species found in the two forests is given in a tabular summary, from which also is seen to what plant community the different species belong. Some studies were made on early and recent developments and successions of the forests, partly by investigation of tree-pollen in some peat-bogs, partly by field observations.

The importance of the paper may be as follows: The investigation and mapping of soils and vegetation at the same areas with consideration taken to geology, topography, soil profile, plant communities and their developments are combined to a whole. Thereby light was thrown upon many interesting things concerning the ecology of the forest and the value of geology and soil science in forestry. Geology must be considered to have a great importance to forest growth in North Sweden because it determines together with topography and climate the groundwater conditions. The most productive forests are confined to slopes where sands or gravels occur, which are percolated by groundwater. Sandy areas, where the level of groundwater lies at a great depth are on the other hand covered by dry, lichen-rich pine forest, which grows very slowly. Small variations in dryness of the soil, caused by the tratigraphy of underlying Quaternary sediments, were found to cause variations in the types of forest. *O. Tamm.*

Tamm, O., Markprofilen i försumpade terränger. (Profile versumpfter Böden.) Vortrag in »Geologiska Föreningen», G. F. F. Bd 49, S. 475—481. 1927.

Verf. hat verschiedene Bodenprofiltypen auf den Versuchsfeldern in Kulbäcksliden (Västerbotten) und Rokliden (Norrbotten), welche der Forstlichen Versuchsanstalt Schwedens gehören, studiert. Es gibt da viele Typen von Wald- und Sumpfböden, die in typischen Moränengebieten entwickelt sind. Verf. hat folgende Bodentypen auf Moräne beschrieben und kartiert:

1. Eisenpodsol mit Rohhumus, der auf trockenen Flächen mit relativ tiefem Grundwasserstand herrscht. 2. Zwischenstufe von Eisen- und Humuspodsol mit Rohhumus oder dünnem Torf. Grundwasserniveau liegt ziemlich hoch. 3. Humuspodsol mit schwacher Anreicherung von Kolloiden n der B-Schicht uud Rohhumus bezw. dünnem Torf. Grundwasserniveau hoch. 4. Humuspodsol mit starker Anreicherung von Kolloiden in der B-Schicht und Rohhumus bezw. dünnem Torf, Grundwasser hoch. 6. Humuspodsol mit schwacher Anreicherung von Kolloiden in der B.-Schicht, Torf mächtig (mehr als 30 cm), Grundwasser sehr hoch. 7. Unpodsolierter Sumpfboden, Grundwasser sehr hoch.

Die verschiedenen Bodentypen stehen in engster Beziehung zu den Feuchtigkeits- und Grundwasserverhältnissen. Das Grundwasser im Eisenpodsol st reich an gelöstem Sauerstoff, aber fast frei von gelöstem Eisen. Im Humuspodsol und in dem unpodsolierten Sumpfboden ist das Grundwasser im allgemeinen arm an Sauerstoff, enthält aber, ja ist oft sehr reich an zweiwertigem Eisen, das als Ion vorkommt. Gleihorizonte mit Limonitausscheidungen stehen mit dem Vorkommen von eisenhaltigem Grundwasser und sauerstoffhaltiger Bodenluft in Zusammenhang. Wo das Grundwasser sich ziemlich stark horizontal bewegt, kommt kein Gleihorizont vor, auch ist die Kolloidanreicherung in der B-Schicht hier schwach oder fehlt. Es scheint, als ob die Grundwasserströmung das Absetzen von Kolloiden verhindert und die schon abgesetzten wegführt.

Wo der Torf mächtig ist, z. B. mehr als 50 cm, und zugleich stark verwest, hören die bodenbildenden Prozesse in der Moräne unter dem Torfe auf. Die Flecke unpodsolierter Sumpfböden müssen immer einen hohen Grundwasserstand gehabt haben. Hier fing die Torfbildung gleich zu Anfang an. Darum hat keine Podsolierung hier stattfinden können. Diese Flecken sind als die ältesten Versumpfungen anzusehen. Die Bodenuntersuchungen haben also eine Methode gegeben, zwischen primären und sekundären Versumpfungen zu unterscheiden. Das wurde von den gleichzeitigen pollenanalytischen Untersuchungen des Torfes derselben Lokalitäten durch C. Malmström in schöner Weise bestätigt. M. fand, dass einige Flecken von sehr alten Torf-agern bedeckt sind, andere von jüngeren. Im allgemeinen decken sich die erstgenannten mit den Flecken unpodsolierten Sumpfbodens.

Chemische Untersuchungen über die Zusammensetzung der verschiedenen Schichten der Bodentypen sind in ziemlich grossem Umfang angestellt worden. Dabei wurde der Gehalt an anorganischen Kolloiden mit der Methode des Verf.'s untersucht.

Die Untersuchungen haben wichtige Beiträge zum Verständnis der Waldversumpfung in Nordschweden geliefert. Das Bodenprofil hat sich als ein empfindlicher Indikator der Feuchtigkeitsverhältnisse erwiesen. Dadurch werden die Bodentypen hoffentlich in der Zukunft wertvolle Hilfsmittel bei der Wald- und Bodenpflege werden. *O. Tamm.*

Tamm, O., Några synpunkter på skogsmarkens fuktighetstillstånd. (Einige Gesichtspunkte betreffs der Feuchtigkeitsverhältnisse des Waldbodens.) Skogen 1927, nr. 11.

Die Feuchtigkeitsverhältnisse des Waldbodens, die für die Waldbäume sehr wichtig sind, sind sehr eng mit den geologischen Verhältnissen verknüpft. Natürlich ist das Zusammenwirken mit dem Klima dabei entscheidend. In Schweden kann der Felsgrund meistens als praktisch undurchlässig für Grundwasser betrachtet werden. Die Feuchtigkeitsverhältnisse werden darum durch das Klima, die Topographie, die Stratigraphie und Struktur der Geologischen Ablagerungen, des Bodentypus und der aktuellen Vegetation bestimmt. Ton- und stark verweste Torfablagerungen haben im allgemeinen kein Grundwasser, wenn man darunter ein Wasser versteht, das sich frei unter dem Einfluss hydrostatischer Kräfte bewegen kann. Torf- und Tonböden bilden darum als Waldböden besondere »Feuchtigkeitstypen», die sehr kurz besprochen werden. Dagegen werden die grundwasserführenden Bodenablagerungen eingehender behandelt und in verschiedene Gruppen nach dem Wasserverhältnissen geteilt.

A. Waldböden mit tiefem Grundwasserstand. Die Wurzeln der Bäume erreichen nicht das Grundwasser. Die Feuchtigkeitsverhältnisse werden stark von der Struktur der Bodenablagerung (des Untergrunds) beeinflusst. In Nordschweden ist dieser Einfluss besonders stark und überwiegt allen anderen. In Südschweden kann er dagegen durch die Eigenschaften des vorhandenen Bodentypus in einer Art Gleichgewicht gehalten werden. Man findet darum in Nordschweden einen sehr strengen Zusammenhang zwischen Waldtypus und Geologie. In Südschweden fällt dieser Zusammenhang weniger ins Auge, weil es vorkommt, dass die bodenbildenden Prozesse, die zum Teil durch waldgeschichtliche Ursachen bedingt sind, einen groben Kies in einen kolloidreichen, Feuchtigkeit zurückhaltenden Boden (brauner Waldboden) verwandelt haben. Der Einfluss der Geologie ist jedoch auch hier gross und äussert sich in der Beständigkeit des Bodentypus und der Bonität.

B. Waldböden mit hohem Grundwasserstand. Die Verhältnisse sind sehr verschieden, wenn das Grundwasser still steht oder sich in horizontaler Richtung bewegt. Im ersten Fall liegt ein Boden vor, der sehr zu Versumpfung geneigt ist. Grosse Areale von Torfböden in Nordschweden sind auf Flächen mit hohem Grundwasser entstanden. Wo das Grundwasser sich bewegt entstehen dagegen sehr produktive Wälder. Dabei ist es besser, je schnelle das Wasser sich bewegt und je höher der Grundwasserspiegel liegt. Im humiden Nordschweden, wo der Grundwasserspiegel im allgemeinen hoch im Bodenprofil liegt ausser in mächtigen Sanden, kommen sehr grosse Flächen vor wo das Grundwasser sich nahe der Bodenoberfläche bewegt. Natürlich ha hier die Neigung einen entscheidenden Einfluss. Aber auch die Struktu der Bodenablagerung ist sehr wichtig. Ein Kies ist hier das beste. Die schönsten Fichtenwälder im nördlichsten Schweden stehen oft auf Kies, der vo

Vasser durchrieselt ist. Somit haben die Lagerungsverhältnisse auch in diesem 'all einen gewaltigen Einfluss auf den Waldwuchs. Ganz im Gegensatz zur andwirtschaft, wo tonige und lehmige Böden die besten sind, sind in der 'orstwirtschaft Nordschwedens die Sand- und Kiesablagerungen oder überaupt durchlässige Ablagerungen die besten, wenn sie nur von Grundvasserströmen durchzogen sind. Wenn nicht, sind sie wie in der Landwirtchaft nur schwach produktiv. Wo in günstiger Weise durchrieselte Böden n Südschweden vorliegen, gibt es sehr gutwüchsige Fichten und Laubwäler, sogar mit Buchen. Solche Böden spielen aber hier eine ganz untergerdnete Rolle, weil das Grundwasser allgemein tiefer im Boden steht als in Jordschweden.

Für die Waldwirtschaft wäre es nützlich, Böden von verschiedenem Feuchigkeitstypus zu unterscheiden. Dabei ist das Hülfsmittel eine geologische ufnahme im Felde zusammen mit einer forstlich-bodenkundlichen. Die eologische Aufnahme sollte unter anderem die Wasserverhältnisse der bereffenden Lokalität klären. *O. Tamm.*

Histoire de la géologie.

ENZÉN, NILS, En skriftväxling år 1761 mellan Daniel Tilas och prosten Abraham Miödh angående fyndet av ett fossilförande kalkstensblock på ön Nagu, jämte några anmärkningar därtill. (Ein Schriftwechsel im Jahre 1761 zwischen Daniel Tilas und dem Probst Abraham Miödh über den Fund eines Blockes fossilienführenden Kalksteins auf der Insel Nagu, nebst einigen Bemerkungen dazu.) G. F. F., Bd 49, pp. 259—272.

TILAS (in Stockholm), der schon früher (1742) in einer gedruckten Rede ie Ansicht ausgesprochen hatte, dass grössere Geschiebe mit Treibeis forteschafft worden wären, spricht sich in den Schreiben an MIÖDH im Jahre 761 zugunsten einer ähnlichen Art des Transports während eines ehemagen höheren Wasserstandes auch bezüglich eines auf Nagu im Finnländischen Schärenhof, 3 Meilen SW von Åbo, gefundenen Blockes aus. TILAS abe, auch im skandinavischen Hochgebirge, Tausende von Beispielen geehen, wie lose Steine mehrere Meilen weit von ihrem ursprünglichen Kluftrte geführt worden seien. Ein ganz besonders deutliches Beispiel dafür eben, wie er (TILAS) in einem 1740 veröffentlichten Aufsatze gezeigt habe, ie Geschiebe von Rapakiwi in der von ganz anderen Gesteinen aufgeauten Gegend zwischen Åbo und dem NW davon liegenden Rapakiwiebiet. — Für Geschiebetransport mittelst Treibeis in dem Finnländischen chärenhof trat im Jahre 1772 auch P. A. GADD (in Åbo) nebst seinem Schür E. WIDENIUS ein. *N. Zenzén.*

Förteckning

över svensk geologisk, paleontologisk, petrografisk och mineralogisk litteratur för år 1927.

(Jämte äldre tillägg.)

Av

R. Sandegren.

(Anmärkningar och kompletterande uppgifter mottagas med tacksamhet under adress Sveriges Geologiska Undersökning, Stockholm 50.)

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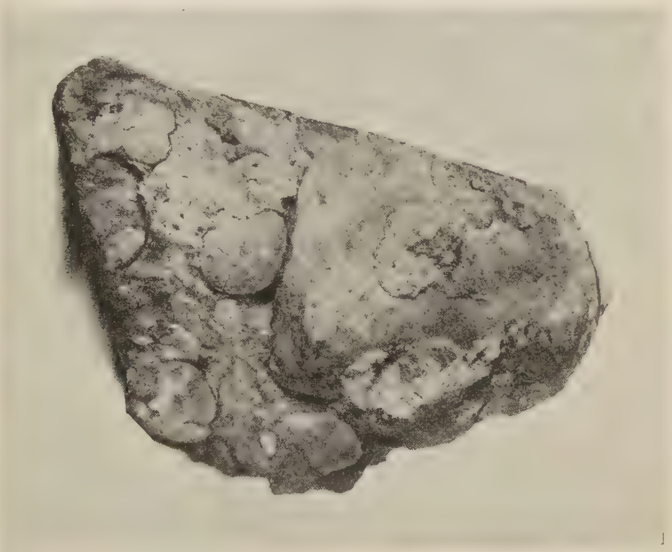
Notis.

Konglomerat inom den kambriska sandstenen i Djupadal, Västergötland.

Av

Ivar D. Wallerius.

Till de förut gjorda fynden av konglomerat inom övre delen av Västergötlands kambriska sandsten — sammanställda av dr Westergård i G. F. F. Bd 50, s. 200, 201, — kan läggas ett nytt sådant, nämligen från den klassiska lokalen Djupadal i Karleby s:n. Vid ett besök därstädes 1923 iakttog jag i ravinens nedre del, i norra sluttningen strax vid dalbottnen några tunna bankar av sandsten. På denna nivå hade jag aldrig förut funnit sandsten i dagen; bankarna måste enligt sitt läge tillhöra sandstenslagrets (»Lingulidsandstenens») översta del. Bergarten i dessa bankar befanns vara ett väl utbildat konglomerat. Då jag i år besökte platsen, återfanns visserligen detta lager, men det var



A. Viberg foto.

Sandstenskonglomerat från Djupadal. $^1/_2$.

mindre tillgängligt till följd av ras. Det var nu att finna i randen av bäcken, där denna gör en krök åt norr, innan den något längre ned rinner utför de trappformade sandstenshällarna.

Bollarna i konglomeratet äro väl rundade och avslipade, merendels något platta. Storleken är ganska växlande, största iakttagna mått är 16 cm. De bestå av en tämligen finkornig och hård, brunaktig sandsten med insprängd svavelkis, som dessutom fyller sprickor i bollarna. De ligga i en något grovkornigare sandstensmassa, även den rik på svavelkis. På sina ställen är sandstensmaterialet nästan helt ersatt av svavelkis, så att bollarna äro omgivna och sammanhållna av detta mineral. Konglomeratet ser då rätt egendomligt ut.

Eftersom bollarna i motsvarande konglomeratbildningar annorstädes ofta bestå av fosforitsandsten, låg det nära till hands att förmoda liknande sammansättning hos Djupadalskonglomeratets bollar, vilkas utseende också tydde därpå. Emellertid har dr G. KARL ALMSTRÖM vid undersökning av såväl bollarna som det övriga materialet konstaterat närvaron av blott en ytterst ringa mängd fosforsyra. Även kalkhalten förefaller obetydlig. Några spår av fossil ha ej anträffats.

Paradoxidesskifferns gränslager till sandstenen iakttog jag någon gång på 1890-talet. Det är en blåaktig skiffer med oregelbundna, ljusgula partier av sandstensmaterial, något erinrande om Ållebergs Staurocephalusskiffer.

Göteborg, nov. 1928.

Mötet den 1 november 1928.

Närvarande 42 personer.

Hr B. Asklund höll ett av profiler, kartor och ljusbilder belyst föredrag om Strandflaten på Sveriges Västkust. Föredr. demonstrerade inledningsvis ett antal profiler illustrerande de relativa höjdvariationernas fördelning inom södra Sverige. I profildiagrammen hade topografiska kartornas höjdsiffror fått beteckna ordinatpunkter grupperade efter längdavstånd i bestämda väderstreck. Emedan ett enda profilsnitt genom en topografisk karta skär alltför få höjdsiffror hade föredr. samlat alla höjdsiffror inom bredder av merendels 10 km. Profilerna representerade sålunda höjdsiffrorna inom långsmala rektangelavsnitt. Höjdsiffrorna hade efter sin karaktär givits olika beteckningar i fyra grupper 1) toppunkter och i allmänhet »torrt» belägna terrängpunkter, 2) sjöytor, 3) myrytor, angivande den ungefärliga höjden av fornsjöarnas passpunkter samt 4) en punktbeteckning för strömmande vattendrag. Skilda kurvlinjer hade sedan dragits för toppunkterna och för underytan av vattendragens punkter. De tvenne kurvornas förlopp belyser förträffligt landskapets geomorfologiska karaktär.

Beträffande sydligare Sveriges urbergsterränger, och av profiler lagda från sydligare Halland åt öster över till Öland (särskilt profilrektangeln från södra gränsen av kartbladet Halmstad över till södra gränsen av kartbladet Kalmar) framgår med övertygande tydlighet förekomsten av tre geomorfologiskt skilda zoner: 1) östligast en in under Ölands kambriska avlagringar relativt brant stupande prekambrisk peneplanzon, 2) ett över sydliga Sveriges urbergsyta utbrett nästan horisontellt peneplan, som i öster skarpt skär över det prekambriska peneplanet, 3) en västlig kustzon bildande en lågslätt, krönt av relativt höga monad nocks och åt öster karakteriserad av hydrografisk fallzon, avgränsad mot det sydsmåländska höglandet. Nordligare profilsnitt uppvisa huru den mellersta peneplanzonen så småningom förtonar mot norr: redan profilsnittet lagt vid sydkanten av kartbladet Kungsbacka samt åt öster till sydkanten av kartbladet Oskarshamn uppvisar, att genom urbergstopparna det prekambriska peneplanet spänner ett vackert bågvalv över landet. Kustslätten kan med angivna metod påvisas ännu inom kartbladet Göteborg, här emellertid bildande ytterst flacka och lågt belägna dalgångar omgivna av brant uppstickande höjdmassiv, vilkas breda och plana överytor beteckna det från Västergötland neddykande prekambriska peneplanet.

Föredr. skulle framdeles för Geol. För. angiva skälen för sin uppfattning, att den sydsvenska postkambriska peneplanbildningen utformats under långa tidsskeden, men syntes ha nått sin fullkomning i medelmesozoisk tid. Dagens föredragsämne inskränkte sig sålunda till en karakteristik och tolkning av den västsvenska kustslätten, eller som förf. utan tvekan betecknade denna, den sydvästsvenska Strandflaten. Dennas neddenudation in i det sydsvenska medel-mesozoiska peneplanet angiver à priori kustslättens relativt unga geologiska ålder.

Föredr. hade länge haft sitt intresse riktat på de anförda geomorfologiska dragen, men först i år kunnat få tillfälle till en månads fältstudier över dem. Redan profilstudiet över strandflaten hade angivit följande arbetsprogram. 1:o) Strandflatens begränsning i öster angiver en markerad terrassbrant. Är denna en tektonisk företeelse eller orsakad av denudation? 2:o) Kustslätten dyker i Sydhalland in under det halländska kritområdet. Är sålunda strandflaten en sub-kretaceisk bildning och förekomma inom dess områden rester av en tidigare sammanhängande kritformation? 3:o) Sjunker verkligen strandflatens östliga avgränsning, från c:a 80 à 100 meters höjd i Sydhalland, till havsytan i Göteborgstrakten, såsom kartprofilerna angiva?

De geomorfologiska studierna utmynnade i följande karakteristik av strandflaten. Denna är en låg rikligt sedimentklädd urbergsyta av peneplanartad karaktär, som upptill avgränsas av vidsträckta urbergsflackhällar, vilka såväl gentemot höglandsområdet i öster som vid de talrika monad nock-bergen på dess yta begränsas av en skarpt utskuren, vanligen väl blottad bergterrass. Denna är icke tektoniskt anlagd utan är en denudationsföreteelse. Inom de sydhalländska östliga områdena, där strandflatens terrass stiger över den gotiglaciala marina gränsen, är terrassen så starkt moräntäckt, att man ej med någon större noggrannhet kan bestämma dess höjdläge (S om Ysby 80—90 m). På Hallandsåsens NV-sida (N om Knösen, 518 fot) finnes en vidsträckt men föga bred bergterrass sluttande från c:a 100 till 75 m:s höjd. En motsvarighet till denna finner man på Hallandsåsens sydsida i det vidsträckta av flacka urbergshällar klädda plan, som sträcker sig från Västra

Karup förbi Grevie, Förslöv och fram till samt förbi Västersjön. Denna flackslätt befinner sig mellan 80—100 m:s höjd samt avgränsas mycket tvärt i N mot den branta centrala delen av Hallandsås. Avgränsningen har enligt framställningen på STEN DE GEERS landformskarta (S. G. U. Ser. Ba. N:o 9) tolkats såsom en förkastningsgräns. EDVARD ERDMANN har å andra sidan ej låtit en dylik mening komma till uttryck på sin bekanta »Geologisk Översiktskarta över Skåne» (S. G. U. Ser. Ca N:o 6, Atlas, Tavla 1). Föredr. kunde ej heller finna något belägg för förkastningshypotesen, men utförde ej tillräckliga fältstudier för en berättigad slutsats i ena eller andra riktningen.[1] I enlighet med vad som senare anförts synes dock sannolikt, att även denna slättbildning är samhörig med den västsvenska strandflaten.

I trakterna norr och öster om Halmstad, där marina gränsen stigit till 60 à 70 m:s höjd och därmed ovanför strandflatens terrass, framträder denna storartat (Harplinge 58—59 m) samt kan sedan följas såväl utmed avgränsningen till det östra höglandet som, mer eller mindre sammanhängande, runt monad nock-bergen (t. ex. Nyårsåsens SO-sida) ända till trakten N om Varberg. Synnerligen vacker och rikligt blottad framträder strandflatens berggrund SO om Falkenberg (t. ex. runt Klockberget vid Eftra kyrka; terrassen å 55—57 m). Öster om Varberg stiger östra höglandet särskilt pregnant och brant upp från terrassen (Alfshög c:a 49 m, Grimeton c:a 42 m, Rolfstorp c:a 40 m). Höglandet är här kraftigt skulpterat och har en vild och säregen struktur med branta smala dalgångar och toppiga bergknallar, som likt ett palissadverk båda det inre höglandets mera storvulna bergshöjder.

N om Varberg från och med Lindbergs och Valinge socknar ändrar landskapet karaktär. Bergkullarna svälla ut till massiv, vars överyta omisskännligt krönes av det prekambriska peneplanet. Strandflaten sammantränges till flacka dalgångar med låga flackhällar. Dalgångarnas bergsidor äro mera avrundade. Man får söka sig till själva kusten för att återfinna strandflatens terrass (Landa 25—27 m, Särö 9—11 m), ännu likväl mycket tydlig, men längre upp, på Onsala-landet, alltmer förtonande. I de breda dalgångarna N om Kungsbacka täckas så småningom dalbottnarnas flackhällar helt av senglaciala och postlitorinala sediment. I fjärdarna framemot Göteborg kommer dock ännu flatens överyta fram i de otaliga små låga skären, vilka ännu bilda en synnerligen distinkt sammanhängande yta, ytterst skarpt avgränsad mot de ofta tvärbranta fjärdsidorna, vilka stiga till 60 à 70 m:s höjd (t. ex. Brottskär). Föredr. hade ej utfört fältstudier V och NV om Göteborg, där dock sjökortens djupsiffror tillräckligt illustrera de väldiga grundbottnarna och visa, att strandflaten här börjar bli submarin. En vidare studie över den submarina strandflaten kräver utförligare material av djupsiffror än sjökorten giva.

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[1] Enl. benäget muntligt meddelande av Statsgeologen HARALD JOHANSSON har ej heller denne, som här utfört detaljerade fältstudier, funnit något som antyder förkastningsbegränsning.

Beträffande såväl strandflaten själv som dess blottade terrasshällar kräves nu endast tillägga, att dessa på samtliga studerade lokaler befunnits glacialrepade och glacialskulpterade.

För att söka eventuella sedimentrester på strandflatens urbergsyta studerade föredr. de förefintliga stenbrottens detaljtektonik, ett arbete, som genom överdirektör A. GAVELINS välvilliga intresse gav föredr. förmånen av Sveriges Geologiska Undersöknings partiella ekonomiska understöd för hithörande fältarbeten. Egentligen endast på Hallandsåsen kröntes sökandet efter sedimentfyllda sprickgångar med framgång. I stenbrotten SV om Dagshög, S om Torekov, anträffades ett trettiotal gångar av rätisk-liassisk kolfragmentförande lera och slamsten. Gångarna följa vanligen Kongadiabasernas spricksystem.

På ett flertal ställen inom strandflatens område i Halland anträffades kretaceisk flinta i otvetydig och icke havsbearbetad morän. På Skreanäs hade föredr. tillfälle se anläggande av flera stenbrott. Vid avschaktande av överliggande morän befanns denna på åtskilliga ställen sänka sig ned i berget som upp till 2 à 3 m djupa hålrumsfyllnader. Moränen är mycket rik på grå flinta av Danienflintans typ. I havsbearbetat morängrus träffas en myckenhet flinta av samma typ i trakten av Boberg S om Falkenberg. Iakttagelserna giva vid handen, att V om Falkenberg under Ätrans flodränna sannolikt en ej obetydlig rest av kritformationen finnes bevarad, vilande i någon flack sänka inom strandflaten.

N intill Lönestig i Morups socken anträffades rikligt med flinta i en undre spetthård morän. I lösare morän förekommer rikligt med flinta och ej så obetydligt med kritkalk nära Hasselås (N om Falkenberg).

O om Höråsen (Tvååkers socken, SO om Varberg) träffas en myckenhet flinta och ej obetydligt av lösvittrad kritkalk i de här upptagna stora moränblottningarna. I de mera högtbelägna moränskärningarna vid Dagsås kyrka och S om Ottersjö herrgård kunde trots ivrigt sökande intet flintblock uppspanas, varför med bestämdhet framgår, att ett kritområde är beläget i dalsänkan mellan Dagsås och Höråsen.

Som Varberg träffas likaså mycket flintblock i moräningrus, som här dock förefaller vågbearbetad till rätt betydligt djup.

På NV-sidan av Särö träffas likaså i havsbearbetat morängrus talrika flintblock ännu vid en m:s djup.

Föredr:s helt hastiga studier över flintans förekomst i morän visar redan, att lokala blockspridningsområden uppträda. Sålunda efterspanades flinta förgäves i vackra moränskärningar i trakten av Ysby; N om Kungsbacka, samt en rad övriga ställen. Hittills anträffad flinta ur morän i Halland har konstant visat sig vara av »Danien-typ», en grå eller grågul mera sällan betonat gulaktig flinta. Det fölle utanför föredr:s kompetens att bearbeta anträffade fossilförande kritkalk- och flintblock.

Beträffande Hallands kustregion ansåg sig föredr. ha vunnit tvenne mycket fasta resultat: 1) kustslätten eller strandflaten är en peneplanartad urbergsyta avgränsad såväl mot det östra höglandet som mot monad nock-bergen medelst en terrass, vilkens anläggning ej är tektonisk. Strandflaten liksom dess terrassavgränsning är preglacial; 2) på strandflaten ligga ett flertal isolerade kritförekomster, antydande att den är subkretaceisk (i rumsbemärkelse).

Med dessa nyvunna erfarenheter vände sig föredr. till det andra av våra kritförande områden, som gränsar intill den sydsvenska urbergsplattan. Föredr. hade här ej utfört fältstudier. Såsom Sten De Geer påpekat, förefinnes en framträdande morfologisk likbeskaffenhet mellan Kristianstadkritområdets kraftigt skulpterade urbergsgrund och Sydhallands. Ett antal enligt förutbeskrivna metod utarbetade nord—sydliga profiler genom Sydsmåländska höglandet samt Kristianstadkritans område belyste ytterligare denna likhet. De genom kritberggrunden uppstickande urbergstopparna, Ryssberget, Ivö klack m. fl., nå upp i eller nära nog upp i nivå med det av föredr. omnämnda »medelmezozoiska» peneplanet. En del av dessa ha uppfattats som småhorstar; om de så äro, kunde förf. nu ej bedöma, men ansåg i varje fall att de underkastats en prekretaceisk och kretaceisk djupvittring, vilken givit dem deras märkliga skapnad. De förevisade profilerna uppvisa ej direkt någon så tydlig terrassbildning som på Västkusten, men vid 90—100 m:s höjd börjar från det sydsmåländska peneplanet en allmän fallzon i floderna och vattendragen (mest markerad i Mörrumsån, mindre i Helgeån). Antydning till en terrass gives dock. Denna faller något under den av Troedsson angivna högsta höjden för mucronatazonens strandbildningar i Åkarpstrakten (110 à 120 m).

Kristianstadskritans våldsamt kraftigt skulpterade urbergsbotten förklarar genom analogierna ett drag av den halländska kustberggrundens geomorfologi, dess starkt brutna relief. Innan krithavet transgredierade över Kristianstadsområdet var som bekant (G. De Geer, Grönwall m. fl.) dess urberg utomordentligt kraftigt sekulärvittrat inom en deciderad kustzon, varom de mäktiga in situ-kaolinmassorna vittna. Så har väl även varit förhållandet i Hallands kustregion.

Den utpräglade strandflatens och dess gränsterrassers uppkomst tolkade föredr. sålunda. När det transgredierande krithavet nådde sin branta och djupförvittrade urbergskust måste en utomordentligt kraftig abrasion inträffat, som förmått blotta friskt urberg. Uppenbarligen rådde ännu under hela överkritans tid ett så milt kustklimat, att kaolin- och lateritvittringen fortsatte konstant, inom transgressionsområdena åtminstone. Därom vittna de kronologiskt vitt skilda led av kritformationen, som nå urbergsytan: de underlagras såvitt känt är i våra trakter alltid av kaolin eller lateritartade vittringsmassor. Marin abrasion och pågående kaolinvittring i förening ha skapat de plana urbergsslätterna och utskurit den övre terrassen. Den senare skulle därmed beteckna krittransgressionens övre gräns. Under vilket skede av övre kritans tid maximaltransgressionen inträffat, överlämnade föredr. åt paleontologernas avgörande. Troedsson har uppvisat, att de högst belägna kritområdena i Norra Skåne tillhöra övre senon. De i morän träffade halländska flintblocken likna å andra sidan Danienflinta. Emellertid beskriver Troedsson »spräckliga» flintor från Åkarpsförekomsterna, vilkas flinta sålunda sakna likhet med skrivkritans. Det synes följaktligen rimligt att även åtminstone en del av Hallands flintor (i morän) kunde tillhöra Mucronata-zonen, en fråga, som naturligtvis får fastställas paleontologiskt. Vår kännedom om de epirogenetiska rörelserna inom sydligaste Sverige under övre kritans tid är dock så fragmentarisk, att frågan huruvida Senon eller Danien transgredierat högst i Halland är ny.

Föredr. ville ej lämna ämnet utan ett par jämförelser med den norska strandflaten. Bland de flerfaldiga tolkningar som givits för dessa syntes den av docent Fr. Enquist i föredrag givna (G. F. F. 1925; ej refererat) ensam satisfiera föredr:s resultat från svenska västkusten. Enquist har framhållit, att fullständigt likartade kustbildningar (både vad monad nock-bergens skapnad och kustplanet beträffar) inom Brasiliens urbergsområden (Victoria) uppkommit genom den vid kusten än mer än i inlandet skärpta lateritvittringen under tropiska klimatförhållanden, samt efter studier av Brasiliens strandflate tolkat Norges likartat. Till Enquists betonande av laterit-djupvittringens beroende av grundvattenytan som base level plain, framhöll föredr. abrasionens avgjorda roll för utpreparerande av den plana strandflaten och primära roll för terrass-zonens markerande. — Föredr. ansåg nödvändigt, att de synpunkter, som anförts beträffande den sydvästsvenska strandflatens uppkomst, tagas i betraktande vid tolkningen av den visserligen så mycket mera storartade men i princip likartade norska. Det föreföll föredrag. nästan à prioristiskt klart, att de så närbelägna företeelserna vore genetiskt samhöriga. Viktigt stöd för denna uppfattning lämnar följande resonemang. Försåvitt bägge »flaterna äro synkront anlagda borde de intaga någorlunda likartat höjdläge å orterna för sammanfallande höjdvärden av yngre, synkrona strandmärken, exempelvis å orter belägna på samma Tapesgränsisobaser. På svenska västkusten dyker strandflaten under havet vid Göteborg vid 25 m:s Tapesgräns. Den norska egentliga strandflaten börjar emellertid redan å 35 m:s T. G. i trakten av Langesundsfjorden på Norges sydöstra kust (föredr. framhöll i sammanhang härmed sin åsikt, att den av FR. NANSEN beskrivna strandflaten från Oslo-fjordens innersta ända ej syntes kunna genetiskt förbindas med de öppna havskusternas nästan sammanhängande strandflate). Emellertid är det å andra sidan genom W. C. BRÖGGERS studier över de arkeologiska nivågränserna inom Oslofjordens områden fullt tydligt, att landhöjningen inom denna del av Norge försiggått avgjort hastigare än redan inom ganska närbelägna svenska trakter. Därmed borde även strandflaten i sydöstra Norge intaga ett högre läge än i södra Bohuslän.

Föredr. framhöll, att han alls icke ville undanskjuta den av NANSEN urgerade uppfattningen av särskilt de lägre strandlinjernas på norska strandflaten ålder och likaså ej heller att strandflaten vidare bearbetats under de kvartära *mare plenum*-stadierna, då Fennoskandia samtidigt intog sitt isostatiska utjämningsläge.

Den sydvästsvenska strandflatens pregnanta lutning från söder mot norr öppnade enligt föredr. nya perspektiv för ett flertal geologiska problemkomplexer. Enklaste förklaringen vore ju, att lutningen skulle orsakas av den ännu ej utjämnade sista glaciala »isostatiska» anomalien. Måtten för den i så fall ännu kvarstående glaciala deformationen synas dock bli alldeles oväntat stora. Det måste därför försiktighetsvis åter betonas, att vår kunskap om de epirogenetiska förhållandena under övre kritans tid är mycket obetydlig beträffande de områden, som här diskuterats. Stor sannolikhet talar visserligen för att Fennoskandia under denna tid intog sitt allmänna jämningsläge, men de sydsvenska områdenas nära grannskap till sedimentgravar möjliggöra här helt komplicerade förhållanden. Det kunde t. ex. i viss mån skönjas av föredr:s helt preliminära isobaskarta från svenska Västkustflatens terrass, att en relativ »överförhöjning» träffat Hallandsåsen. Å andra sidan är det dock tydligt att den ännu ej fullbordade landhöjningen i Sydsverige inrymmes i strandflatens lutningsmått. Föredr. kunde ej ansluta sig till uppfattningen, att den yngsta glaciala »isostatiska» deformationen skulle vara nära nog utjämnad.

Slutligen anfördes, att en detaljerad studie av den sydvästsvenska strandflaten kan med bärande resultat utföras. De medelbart viktigaste resultaten av en dylik studie syfta otvivelaktigt främst till den rent mekanisk-geofysiska problemställning, som för närvarande håller på att allt mer tränga sig fram ur studiet av Fennoskandias kvartära nivåförändringar.

I en kommande uppsats ämnade föredr. ytterligare belysa några synpunkter på de problem som denna helt preliminära studie över den Sydvästsvenska Strandflaten frammana.

Med anledning av föredraget yttrade sig hrr S. DE GEER, G. DE GEER, TROEDSSON, HÖRNER, HAMBERG, CARLHEIM-GYLLENSKIÖLD och föredraganden.

Hr TROEDSSON lyckönskade föredr. till de intressanta och värdefulla resultaten samt fäste uppmärksamheten pa att ett liknande arbete utförts av den amerikanske geologen JOSEPH BARRELL i New Haven och publicerats postumt i American Journal of Science år 1920. BARRELL hade sålunda med användande av ungefär samma metoder som föredr. sökt visa att piedmontterrasserna i norra Appalacherna voro preglaciala abrasionsytor.

Enligt föredr. vore den halländska strandflaten ett abrasionsplan av kretacéisk ålder. Denna kustslätt skulle i sydligaste Halland ligga på 80 m höjd ö. h. och falla norrut. Föredr. hade därför betecknat de ännu högre belägna kritförekomsterna i bjärnumstrakten som en svårförklarlig anomali, något som särskilt gällde förekomsten vid Kulleröd på c:a 110 m höjd. Talaren, som utgick från, att denna siffra snarare vore för låg än för hög, ansåg det emellertid alldeles uteslutet, att denna kritförekomst transporterats i morän. Samtidigt som den konglomeratiska och grusiga kalken avlagrades vid Kulleröd och andra lika högt belägna ställen i trakten, där den ännu anstår, avsatte sig i dalen vid Bjärnums station — nu 90 m ö. h. — fint vitt kritslam, som nästan erinrar om skrivkritan. Med de fakta, som föreligga från bjärnumskritan kunna vi knappast komma ifrån antagandet, att krithavet under mucronatatiden transgrederat trakten emellan Båstads- och Kristianstadsområdena. Även andra förhållanden i Kristianstadsområdet ge vid handen, att mucronatatiden representerar en utvidgning av krittransgressionen i jämförelse med den tidigare mammillatustiden, och att således havet vid slutet av senon haft andra och högre belägna kustlinjer än dem som markeras av halländska kustslättens abrasionshak.

Det av föredr. som mesozoiskt karakteriserade peneplanet i Smålands och angränsande landskaps urberg domineras i sin sydligaste del av en prekretacéisk topografi i påfallande orörd form. Hit höra bl. a. dalar, som övertvära de skånska åsarna (horstarna) och vilkas vattenföring upphört med åsarnas isolering från baklandet, därigenom att en sedimentslätt uppstått, som nu skiljer åsen från urberget i norr. Så begränsas Hallands- och Nävlinge-Linderödsåsarna av kritslätter, Söderåsen av Höör-Ängelholms liasslätt. Samtliga dessa åsar övertväras av dalar, som måhända delvis äro att anse som sprickdalar men i huvudsak — på grund av sin riktning — måste ha uppstått genom erosion. Tvenne sådana särskilt markerade dalgångar på Hallandsås ha samma sydvästliga riktning som de halländska floderna, vilka i nutiden svängt över i rent västlig riktning i sitt nedre lopp, något som är särskilt framträdande med Lagan. Skäralids serpentindal på Söderåsen är förmodligen preliassisk men hör till en annan typ. En nästan sydlig riktning har den dal, som från Hässleholm söderut intages av södra stambanan. Den innehåller vid Tormestorp och söderut basaltkupper (rester av en basaltfyllning?) och är således pretertiär, men utan tvivel även prekretacéisk, enär den ser ut att vara den direkta fortsättningen av Helgeåns dalgång och som sådan fungerat före Kristianstadsslättens uppkomst. En östlig avvikning är utmärkande för de blekingska dalarna. I en av dessa, avloppet från sjön Mien, ligger grovt tuffkonglomerat av ryoliten, påträffat vid Stockholms Högskolas vårexkursion 1928. Nere vid kusten, vid Karlshamn, ligger, som bekant, i samma mera utvidgade dalsystem senonkrita, vars Ostrea-skal sitta fastväxta på vertikala urbergsväggar, som renspolats av krithavet. Allra mest framträdande är dock den prekretacéiska topografien i NÖ Skånes kritområde, vilket tal. under en följd av år ägnat närmare studium.

Dessa antydningar om morfologien ge vid handen, att den av föredr. påvisade kustslätten — under förutsättning att den är kretacéisk — utskurits i ett skärgårdsområde eller ett djupt eroderat landskap, där strandhaken sågats in i redan isolerade höjder, eller att i varje fall den nutida reliefen i kustslätten är äldre än krittransgressionen. Härtill kommer, att kustslätten på Västkusten måste ha deformerats på nordsidan av Hallandsås, varför de anförda höjdsiffrorna på strandhaket måhända hänföra sig till skilda abrasionsperioder.

(Senare tillägg.) Gentemot föredr:s metod att med ledning av den subkambriska landytans stupning under kambrosiluren vid Smålands östkust lägga den subkambriska landytan i s. Sverige som ett slags luftsadel med en beräknad postsilurisk denudation av ett par hundra meter och att på detta sätt bestämma den nuvarande urbergsytan i S. Sverige som mesozoisk skulle med fog kunna invändas, att urbergsytan under Öland med all sannolikhet blivit flexurartat nedböjd och följaktligen lika gärna kan vara en direkt fortsättning av urbergsytan i Småland. I så fall kunde ett abrasionshak vid östkusten, som föredr. ej omnämnde men som framgick av profilerna, vara kambriskt.

Det må vara riktigt, att kustslätten i Halland är kretacéisk (senonisk), men den kan också vara äldre. I varje fall är den djupa reliefen i kustslätten prekretacéisk (här = presenonisk), på samma gång som den representerar ett senare morfologiskt stadium än södra Götalands urbergspeneplan.

Vid mötet utdelades N:o 374 av Förhandlingarna.

Mötet den 6 december 1928.

Närvarande 34 personer.

Ordföranden, hr Hamberg, öppnade mötet, varefter i stadgarna föreskrivna val av funktionärer för år 1929 företogos. Härvid utsågos:

till ordförande hr H. E. Johansson,
till sekreterare hr R. Sandegren,
till skattmästare hr K. E. Sahlström,
till övriga styrelseledamöter hrr B. Asklund och G. Troedsson.

Till revisorer för 1928 års förvaltning valdes hrr J. E. Hede och G. Beskow med hr Erik Nilsson som suppleant.

Januarimötet utsattes till torsdagen den 17 januari.

Hr Nils Magnusson höll ett av kartor och stuffer belyst föredrag om »Aktuella problem från Värmlands gnejsurberg» och framlade i detta resultaten av de under de tvenne senaste somrarna utförda undersökningarna inom Gillbergaskålen i västra Värmland och Nyedstrakten i mellersta Värmland. Genom dessa undersökningar hade föredr. i flera hänseenden kunnat komplettera sina tidigare undersökningar inom Säffletrakten. Resultaten av undersökningarna inom detta senare område hade föredr. framlagt inför Geologiska föreningen i februari 1926 (se härom referat å sid. 118 i band 48 av G. F. F.). De åsikter föredr. då uttalade hade han genom sina nya undersökningar måst modifiera och delvis helt frångå. På grund av den kritik, som efter nämnda föredrag från olika håll riktades mot föredr:s tolkningsförsök, hade han till kartering upptagit ett område inom Gillbergaskålens nordöstra del mellan Glava kyrka och gården Björnö i Gillberga socken. Området må efter den centralt inom området belägna Stavnäs kyrka kallas Stavnäsområdet. En ingående beskrivning av detta område skall lämnas i en avhandling om Gillbergaskålens byggnad, som beräknas inom kort utkomma bland Sveriges geologiska undersöknings publikationer. Här skola endast de viktigaste geologiska dragen framhävas. Profiler lagda vinkelrätt mot bergarternas strykningar visa i skålens centrala delar gnejsigt skiffriga graniter och med dem samhöriga grönstenar. Dessa övergå utåt och nedåt i skiktserien så småningom i allt tunnskiffrigare gnejsiga granitskiffrar. I granitskiffrarna ligga bankar av kvartsiter och fältspatskvartsiter. Glava glimmerskiffer utgör endast en bank av glimmerkvartsit i granitskiffrarna. Under granitskiffrarna ligger en sammanhängande komplex av fältspatkvartsiter och leptitgnejser med fältspatkvartsiterna i komplexens övre delar nedåt så småningom övergående i leptitgnejser, vilka flerstädes äro rikt intruderade och uppbandade av gnejsiga graniter och grönstenar. Under leptitgnejsen ligger en grov glimmer- och ofta hornbländerik intermediär gnejs, vilken uppåt, närmast leptitgnejsen blir mera finkornig och rikt muskovitförande. Under den grova, intermediära gnejsen (Säffleområdets Strömsgnejs) ligger en gnejskomplex med invecklad byggnad huvudsakligen bestående av småkorniga intermediära gnejser uppbandade av grå, på mörka mineral rika gnejser och röda saliska gnejser. Under denna komplex kommer utan några gränser mörka ådergnejser. Den iakttagelsen har över allt kunnat göras att ju djupare man går i gnejskomplexen desto vagare bli gränserna mellan de olika ingående bergarterna och desto större variationerna i strykningsriktningen.

Områdets bergarter hava genomgående en gnejsig utbildning med uppåt i skiktserien mera utpräglat planskiffrig utbildning vilken här kallats gnejsigt skiffrig, nedåt en mera massiv-gnejsig utbildning med mindre sträng orientering av kornens längdaxlar parallellt med skiffrighetsriktningen. Mellan dessa strukturer finnas alla övergångar, vilket visar att bergarterna samtidigt erhållit sina nuvarande strukturer. Genom undersökningar inom områdena mellan Stavnäsområdet och Säffleområdet hade föredraganden övertygat sig om att Stavnäsområdets kvartsiter, fältspatkvartsiter och leptitgnejser övergå i åmålsformationen inom Säffleområdet, att de uppbygga gnejsiga delar av åmålsformationen och alltså äro högmetamorfa suprakrustala bergarter. På samma sätt övergå Stavnäsområdets gnejsiga graniter i Säffleområdets massformiga graniter av Åmåls- och Kroppefjällstyp, vilka kunna bevisas vara intrusiva i åmålsformationen. På grund av den parallellism som ständigt synes råda mellan den strukturella utbildningen av åmålsformationen och graniterna måste de samtidigt hava erhållit sina nuvarande strukturer och den metamorfos, som förändrat dem måste ha inträffat efter eller tidigast i samband med graniternas framträngande. Eftersom breda övergångszoner finnas till gnejsområdena måste även gnejserna hava erhållit sina nuvarande strukturer under samma genomgripande metamorfos, med andra ord: gnejserna äro högmetamorfa bergarter. I föredraget 1926 hade föredraganden framhållit, att så mycket inom Säffleområdets gnejskomplex syntes tala för H. E. JOHANSSONS bekanta hypotes om gnejserna som uppkomna ur en in situ differentierad enhetlig magma, att han ansåg den på allvar böra upptagas till prövning. Erfarenheterna från Gillbergaskålen, sådana de nu föreligga tala dock avgjort däremot och de av föredraganden 1926 framdragna förhållandena synas likaväl kunna tydas genom antagande av en metamorfos på stort djup, vid hög temperatur.

Det är dock ej blott förhållandena inom Gillbergaskålen som tala mot hypotesen om att gnejserna äro in situ differentierade magmabergarter, vilkas nuvarande strukturer äro de primära stelningsstrukturerna. Även gränsförhållandena mellan hyperit och gnejs inom Nyedstrakten synas tala däremot. Som regel omgivas hyperiterna av hyperitdioriter och dessa utåt av ofta granatförande amfiboliter. Där amfibolit saknas, uppträda finkorniga randfacies, vilka ofta hava väl bevarad hyperitstruktur. Dessa randzoner kunna icke tolkas som annat än avkylningskontakter och visa, att hyperiterna äro yngre än angränsande gnejser. Den granitgnejs, som uppträder inom Nyedsområdet, övergår ibland i monzoniter och gabbror med massformig struktur och på några ställen hava brottstycken av dylika anträffats i granitgnejsen. Däremot träffas aldrig brottstycken av hyperit, även om grönstensbrottstyckena anstå hela nära hyperitkontakten. Detta visar, att de med granitgnejsen samhöriga grönstenarna äro av en helt annan karaktär än hyperiterna. Föredr. formulerade sin uppfattning om det genetiska förhållandet mellan gnejserna och hyperiterna så, att hyperiterna äro yngre än gnejserna men att de genom amfibolitbildningen strukturellt införlivats med dem. Detta betyder, att gnejsernas strukturella utbildning tillkommit under en regional metamorfos, senare än hyperiternas framträngande. Även de på Nyedsbladets område gjorda iakttagelserna tala sålunda för att gnejserna i sitt nuvarande skick äro högmetamorfa bergarter.

Med anledning av föredraget yttrade sig hrr H. E. JOHANSSON, HOLMQUIST, SUNDIUS, BENEDICKS och föredraganden.

Hr H. E. JOHANSSON ansåg att i jämförelse med övriga av fördr:s kartor och framställning berörda urbergsgeologiska problem frågan om järngnejsens geologiska natur redan med hänsyn till nämnda bildnings vidsträckta utbredning framstår såsom ett problem av högre storleksordning, och att vid ett ställningstagande i denna fråga givetvis järngnejsens egen karakteristiska beskaffenhet i första rummet måste tagas i betraktande. Beträffande denna sida av saken hade ju föredr. själv i sin tidigare framställning (1926) på ett träffande sätt angivit de för formationen väsentliga karaktärer i fråga om geologisk byggnad och kemiskt-petrografiskt variationssätt, som tala för en uppfattning av järngnejsen såsom en in-situ-differentierad magmamassa. Dessa karaktärers betydelse påverkades ej, om Magnusson nu även på denna punkt synes benägen att återtaga sin tidigare framställning.

I motsats till järngnejsen erbjuder det på östra sidan därom förlöpande Småland—Värmlandsgranitstråket en omisskännlig geologisk heterogenitet av den art, som är att förvänta, då magmorna förflyttats ur sitt ursprungliga differentiationsförband och med m. el. m. märkbar succession intruderats i en preexisterande berggrund. Det är dock möjligt inom detta bergartsbälte att i huvudsak frånskilja ett dylikt intrusivt material, varefter här återstår ett skelett av en äldre bergartsserie, vilken efter allt att döma ursprungligen förmedlat ett kontinuerligt sammanhang mellan järngnejsområdet och östligare Sveriges leptit-gnejsterränger, ehuru detta sammanhang nu endast på ett litet parti av gränszonen (i gränstrakterna mellan Värmland och Västergötland) finnes bevarat i av granitintrusioner någorlunda oskadat skick. Det hade förefallit tal. anmärkningsvärt, att icke något spår av äldre berggrund tyckes hava iakttagits av föredr. inom det av honom karterade avsnittet av granitstråket.

Orsakerna till de till synes så oöverkomliga svårigheter att ernå någon mera konsekvent och acceptabel tolkning av de geologiska förhållandena inom sydvästra Värmlands »skålområde», som mött Magnusson liksom sannolikt även tidigare kartörer av området, trodde tal. i motsats till M. icke vara att lokalisera till områdets nordligare, i typisk geologisk och petrografisk kontinuitet med omgivande järngnejs befintliga delar utan fastmera till bergartsstråkets sydligare fortsättning, och var för sin del benägen föreställa sig, att dessa svårigheter djupast bottnade däri, att den egendomliga bergartsfacies, som här möter, tillhör ett ännu ouppklarat område av petrografin, för vars utredning en utvidgning av våra petrogenetiska föreställningar i ett eller annat hänseende är nödvändig.

Sammanfattningsvis kunde slutresultatet av föredr:s Värmlandskarteringsarbeten i urbergsgenetiskt hänseende närmast betecknas som ett rent status quo på alla punkter av intresse.

Hr Holmquist betygade sin stora tillfredsställelse med det resultat, vartill föredr:s förnyade undersökning av Säffleområdet och Gillbergaskålen lett. Föredr. hade ock i andra fall visat sig förmå att skickligt tillvaratana bergarternas geognostiska relationer i fält och låta dem komma till sin rätt vid den geologiska tolkningen, och därför hade även hr H. haft den förhoppningen, att slutresultatet av föredr:s studier inom området skulle bliva det, som nu på ett så utomordentligt klart sätt framlagts. Särskilt värdefullt syntes det hr H., att föredr.

nu funnit, att regionalmetamorfosen giver förklaringen till gnejsutbildningen, d. v. s. till såväl motsatsen som övergångarna mellan granitleptitområdet och gnejsen. Egentligen är det rätt egendomligt, att det regionalmetamorfiska betraktelsesättet för urbergets vidkommande i senare tid hos oss mött så mycket motstånd. Den regionala deformationen och omkristallisationen av urbergsbergarterna, såväl leptiternas övergång till grova leptitgnejser som graniternas till gnejsgraniter, granitskiffrar, ådergnejser o. s. v., kan ju dock utan svårighet demonstreras inom många områden. Talaren erinrade ock om, att han nyligen visat, att till och med vid den algonkiska veckningen av Dalslandsskiffrarna — sålunda i ett fall då det icke kunde vara fråga om varken magmatiska förlopp eller ens djupmetamorfos — den inre mekaniska metamorfosen deformerat kvartsitsandstenens minsta detaljer. Dess ännu igenkännliga endast några tiondels millimeter stora klastiska kvartskorn hade därvid i vissa fall undergått böjningar av mera än 30°[1], medan omgivande delar av bergartsmaterialet fullständigt förlorat sin ursprungliga struktur och omkristalliserat. — I själva verket hava vi uti den väldiga regionala metamorfos, som i sen arkeisk tid träffat urbergsbildningarna och åstadkommit gnejsbildningen, att göra med ett av de mest intressanta och betydelsefulla fenomenen inom urberget.

Hr SUNDIUS fann föredr:s nya framställning rörande detta viktiga område i mycket tilltalande, men hade svårt finna fog för de gjorda slutsatserna. Tal. konstaterade, att föredr:s uppfattning av fältets geologi undergått en anmärkningsvärd förändring. Vid det tidigare föredraget hade han uppfattat ett flertal gränser såsom skarpa och såsom formationsgränser. Sålunda hade gränsen mellan den s. k. »skålkvartsiten» och den därunder liggande gnejskomplexen tolkats såsom en primär och tydlig avlagringsgräns. Likaledes ansågos vissa såsom yngre uppfattade graniter vara tydligt skilda från båda de nämnda bildningarna. Vid tillfället i fråga ansågos slutligen bevis för en överskjutning inom »skålen» förefinnas, och ansågos de vara av tillräckligt bindande art för att t. o. m. måtten för den skedda rörelsen skulle kunna diskuteras.

Vid ett besök å platsen något senare tillsammans med överdir. GAVELIN och föredr. hade tal. för sin del blivit övertygad om, att det erbjöde stora svårigheter att upprätthålla ovannämnda gränser, liksom även överskjutningsteorien. Speciellt var det tydligt, att det såsom »skålkvartsit» betecknade lagret ej vore annat än en salisk, delvis bandad, finkornig, röd gnejs. Bandningen i densamma åstadkoms av smala, grå ränder, rikare på kvarts, delvis även på plagioklas, än den omgivande röda huvudbergarten. Denna kemiska differentiation i lagret kunde näppeligen återföras på en sorterings- och avlagringsprocess. Däremot hade tal. under exkursionen fått det intrycket, att »skålkvartsiten» ej utan vidare borde sammanföras med Åmålsformationens bergarter i söder.

Föredr. hade nu beträffande gränsförhållandena kommit till en uppfattning, som i det väsentliga överensstämde med tal:s, med undantag endast för relationerna mellan »skålkvartsiten» och Åmålsbergarterna. Ej heller mellan dessa kan enligt föredr. någon gräns dragas. Tal. ville dock beträffande denna fråga ställa sig avvaktande. Området erbjöde alltså enligt den nu givna framställningen det förhållandet, att man ingenstädes inom detsamma kunde uppdraga några verkliga gränser, utan samtliga bildningar flyta diffust över i varandra. Icke desto mindre ansåg sig föredr. liksom tidigare kunna med säkerhet skilja mellan samma tre formationer som tidigare, om med samma antagna åldersskillnad mellan »skålkvartsiten» och gnejskomplexen framgick dock ej av föredraget. Såsom förklaring till de diffusa gränserna hade föredr. nu antagit en »yngre» metamorfos, och såsom konsekvens härav hade han även måst skriva järngnejskomplexens egenartade byggnad i detalj och i stort på metamorfosens konto. Drager man emellertid ut konsekvenserna av föredr:s nya iakttagelser beträffande gränsförhållandena, är det tydligt, att de medföra såsom slutligt resultat, att även Åmålsformationen ej kan avgränsas från gnejskomplexen, och detta syntes tal. vara den verkliga förklaringen till föredr:s nya ställningstagande. Tal. ville för sin del säga ifrån, att detta »metamorfosmoment» i föredr:s nya tolkning av områdets geologi i hög grad hade skenet av en hjälphypotes.

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[1] G. F. F. 18 (1926): 425.

Föredr. hade utan vidare kommentarer angivit en metamorfos såsom orsak till de diffusa gränsförhållandena liksom till järngnejsens byggnad. Tal. ville i korthet antyda arten av de fenomen, som skulle förklaras. Det räcker ej med en deformation av vederbörande bergartskomplexer och en samtidigt alstrad skiffrighet. Med den senare, som f. ö. inom stora delar av järngnejskomplexen är föga utvecklad eller saknas, är kombinerad en kemisk uppdelning av bergartsmaterialet i band- och lagerform i stort och i smått. Inom de »yngre» graniterna, som delvis äro skiffriga, inställer sig en likartad bandning, konsekvent likriktad med skiffrigheten och bunden i sin utbredning till densamma. Den genetiska samhörigheten och liktidigheten av bådadera är uppenbar. En detalj av samma art är den redan omnämnda bandningen i »skålkvartsitens» gnejs. Då denna bandning saknas i de massformiga delarna av de »yngre» graniterna, måste den vara uppkommen sekundärt, samtidigt med och förmedelst den antagna metamorfosen, vilket förutsätter »metamorfa» differentiationsprocesser av omfattande art redan i graniterna och i än större omfattning i järngnejsen. Tal. påpekade vidare, att den lagerartade byggnaden av järngnejsen över huvud taget ej kunde tänkas uppkommen genom deformation av en tidigare, massformig, inhomogent byggd berggrund. För en deformation av de mått, som här komma i fråga, måste en utomordentlig plasticitet förutsättas, och tal. ansåg, att utbildningen av bandstrukturen i denna ofantliga bergartsmassa endast kan ha skett i en magma i flytande tillstånd. Ville föredr. gå in för en »metamorf» förklaring kunde tal. ej förstå annat än, att han finge driva metamorfosen till fullständig uppsmältning.

Tal. ville taga fasta på det av föredr. bestyrkta faktum, att »skålbergarterna» ej kunde skiljas ut från järngnejsen. Vilken ställning till denna senare Åmålsformationen intager, blir en uppgift för vidare undersökningar att visa, och även om resultatet av dessa skulle bli, att gränsförhållandena även at detta håll äro diffusa, blir saken ej hjälpt genom ett hypotetiskt antagande av en metamorfos. Man står här enligt tal:s mening inför en fråga av annan art, nämligen frågan om det primära sambandet mellan våra gnejser och leptit-hälleflintformationen, och detta spörsmål är ännu ej klargjort.

Hr Benedicks framhöll, att man inom metallografin, beträffande tolkningen av den bandstruktur, som uppträder efter mekanisk deformation vid högre temperatur, har hjälp av den erfarenhet som vunnits inom petrografin. Omvänt torde den inom metallografin, under mer eller mindre väl definierade omständigheter, vunna erfarenheten kunna vara av nytta för petrografin. De segringsföreteelser — innebärande en avsevärd »differentiation», d. v. s. lokala skillnader i sammansättning — som under vissa omständigheter uppträda vid smidning eller valsning av metaller utöver den rena på pressningen beroende parallellstrukturen, äro i själva verket synnerligen påfallande, ehuru det rör sig om bearbetningstemperaturer vida lägre än smälttemperaturen. En utomordentligt stor plasticitet (låg inre friktion) kan givetvis vid högre temperatur förefinnas även i fast tillstånd. När hr Sundius, på grund av utbildningen av bandstruktur i en stor bergartsmassa, ansett nödigt antaga att materialet befunnit sig i flytande tillstånd, syntes böra framhållas, att dylik uppfattning ingalunda vore fysikaliskt nödvändig. Även relativt ringa lokal skillnad i den inre friktionen hos ett fast material måste vid tryckpåverkan vid högre temperatur kunna giva upphov till en påfallande bandstruktur. Som grundprincip torde därvid kunna uppställas, att delar med lägre inre friktion vid utpressning bilda sammanhängande band, under det att delar med högre motståndskraft måste bilda mindre kraftigt utsträckta, mer eller mindre isolerade partier.

Till Geologiska Föreningen insänd litteratur.

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Geolognytt.

Vid ett kamratligt samkväm den 22 mars 1928 i fil. d:r H. VON ECKERMANNS privata vetenskapliga laboratorium beslöts på förslag av professor PERCY QUENSEL att bilda ett svenskt mineralogiskt sällskap, vilket omedelbart konstituerades, varvid det uppdrogs at en organisationskommitté bestående av professorerna A. HAMBERG, P. QUENSEL, H. BACKLUND och G. AMINOFF samt docent H. VON ECKERMANN med den senare som sammankallande, att utarbeta förslag till stadgar, samt förbereda Sällskapets arbete.

Sedan stadgeförslaget nu föreligger färdigt har Svenska Mineralogiska Sällskapet kallats till sitt första allmänna sammanträde den 14 januari, och komma dess förhandlingar att enligt erbjudande från Geologiska Föreningen refereras i G. F. F.

Styrelsen för Göteborgs högskola har till professor i geografi (med handelsgeografi) och etnografi fr. o. m. 1 januari 1929 kallat och utnämnt docenten fil. dr friherre STEN DE GEER, Stockholm.

Av bergsingenjör HANS LUNDBERG, som f. n. befinner sig på ett par månaders besök i Sverige i syfte att förvärva flera medarbetare, hava följande uppgifter lämnats rörande de svenska geologer och bergsingenjörer, som arbeta i Amerika såsom prospectörer. Själv har ingenjör LUNDBERG sedan 1923 arbetat som field manager för Swedish American Prospecting Corporation och Swedish American Prospecting Company of Canada Ltd såväl inom U. S. A. som Canada och har på sista tiden specialiserat sig på praktiskt geologiska undersökningar och malmletning i norra Canada och Newfoundland. Bergsingenjör K. SUNDBERG, sedan 1927 även field manager för samma bolag, har företrädesvis ägnat sig åt lösandet av problemen rörande oljeletning med resultat att de svenska geofysiska metoderna framgångsrikt kunnat upptaga konkurrensen med tyngdkraftmätningar och seismiska metoder. SUNDBERG har jämte bergsingenjör F. KIHLSTEDT efter oljeletning i Polen, Galizien, Tjeckoslovakien, Österrike, Rumänien och Jugoslavien sedan 1927 varit sysselsatt i Amerika. Fil. kand. E. DAHLSTRÖM är sedan 2 år malmletare i Canada och Newfoundland efter att förut hava arbetat 3 år i Namaqualand och N. Rhodesia i Sydafrika. Fil. kand. E. YGBERG har arbetat 3 år i Canada och Newfoundland. Bergsingenjör A. NORDSTRÖM har i 1 år varit oljeletare i Texas och Louisiana samt malmletare i New Mexico och Alaska. Bergsingenjör E. HUSBERG var sedan 1923 malmletare i bolagets tjänst i U. S. A., Canada, Alaska och Newfoundland men etablerade sig 1928 såsom konsulterande ingenjör i Newfoundland.

Dessutom syssla bergsingenjör A. WIESLANDER och diplomingenjör I. TENNBERG med malmletning i Holl. Indien och ingenjör K. STENBERG med oljeletning i Centraleuropa.

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